GEOLOGICAL SURVEY OF CANADA.

ALFRED R. C. SELWYN, F.G.S., Director.

REPORT OF PROGRESS

FOR

1870-71

OTTAWA:
PRINTED BY I. B. TAYLOR, 29, 31, AND 33, RIDEAU STREET.
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ERRATA.

Page 3, top line, *for* flask *read* flash

,, 4, line 18 from bottom, *for* fact *read* facts.

,, 5, ,, 17 ,, top, *after* 8,000 *add* feet.

,, 7, top line, *for* is *read* are.

,, 7, line 20 from bottom, *for* through *read* amongst.

,, 8, ,, 10 ,, ,, *for* distributions *read* distribution.

,, 281, ,, 16 ,, ,, *for* 1670 *read* 1870.

,, 284, ,, 17 ,, top, *for* from *read* to.

,, 285, ,, 5 ,, ,, *for* Chibogomou *read* Wakanotiche.

,, 286, ,, 2 ,, ,, *for* eighteen *read* eighty-one.

,, 286, ,, 17 ,, ,, *for* descended *read* ascended.

,, 286, ,, 6 ,, bottom, *for* of the mile *read* to the mile.

,, 287, ,, 18 ,, ,, *for* room *read* river.

,, 288, ,, 12 ,, top, *after* as far as *add* Lake Ashuapmouchouan, the river generally runs with the strike of the rocks, their dip being E. < 38° at the bend, and E. 32° at the lake. On the lower half of the distance from,—

,, 291, line 6 from top, *for* island *read* islands.

,, 292, ,, 13 ,, ,, *for* four *read* fifty-four.

,, 293, ,, 15 ,, bottom, *for* expanses *read* exposures.

,, 294, ,, 10 ,, ,, *for* S. 22° W. and N. 22° E. *read* S. 41° W. and N. 41° E.

,, 325, ,, 5 ,, top, *for* Bic *read* Pic.

,, 327, ,, 13 ,, bottom, *for* portage *read* portages.

,, 328, ,, 9 ,, top, *for* on average *read* on an average.

,, 331, ,, 17 ,, bottom, *for* northeastward *read* northwestward.

,, 334, ,, 7 ,, top, *after* ditto at *read* upper.

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Note.—There are neither maps, plans, nor sections with the present volume. Such as are necessary for the better understanding of the Geology of Southern New Brunswick, it is proposed to publish at a future time, with a Supplementary Report on that region, now in preparation by Messrs. Bailey and Matthew. The manuscript maps which accompanied the reports of Messrs. Robb, Richardson and Bell, contained in the present volume, will appear when the results of farther explorations shall have been added to them.

GEOLOGICAL SURVEY OF CANADA.

MONTREAL, 3rd May, 1871.

SIR,—Herewith I have the honor to transmit to you, for the information of His Excellency the Governor General in Council, the accompanying Reports relating to the progress of the Geological Exploration of the Dominion, for the years 1870–71.

I have the honor to be,

Sir,

Your most obedient servant,

ALFRED R. C. SELWYN,

Director of the Geological Survey.

The Honorable JOSEPH HOWE,

Secretary of State for the Provinces.

Ottawa.

SUMMARY REPORT

OF GEOLOGICAL INVESTIGATIONS,

BY ALFRED R. C. SELWYN.

GEOLOGICAL SURVEY OFFICE,
MONTREAL, 1st May, 1871.

To the Hon. JOSEPH HOWE, M.P.,
Secretary of State for the Provinces, Ottawa, Ontario.

SIR,—In the Summary Report of progress which I had the honour to submit last year, various reports then in the press were enumerated, and others were mentioned as being in course of preparation. The former have since then been published in a volume of 475 pages, accompanied by five geological and topographical maps to illustrate the text. One thousand copies of this volume have been printed, and 674 copies have been distributed in the Dominion, the United States, in Great Britain and the Colonies. It has been translated into French by the official translators of the House of Commons and a French edition of 500 copies will be ready shortly. A number of these will be distributed to scientific institutions in Continental Europe. Of the undermentioned reports included in the volume, a separate edition has been printed for the convenience of persons especially interested in the subjects to which they allude.

Publication of Report for 1870.

1. On a part of the Pictou Coal-field, by Sir W. E. Logan and Mr. Edward Hartley, with an appendix on coals and iron ores, and a geological map.
2. Report on the coals and iron ores of Pictou County, Nova Scotia, by Mr. Edward Hartley.
3. Notes, by Mr. Edward Hartley, on Spring Hill coal.
4. Report of Mr. H. G. Vennor on Hastings County, Ontario, with geological map.
5. Report on the Goderich Salt Region, by Dr. Hunt.
6. Report on iron and iron ores, by Dr. Hunt.
7. Report of Mr. Robert Bell on the geology of the north-west side of Lake Superior, and on the Nipigon district, with a map.
8. Report on the north shore of the lower St. Lawrence, Laurentian, and Labradorite Rocks, by Mr. James Richardson.

Publications of the Geological Survey.

Appended is a list of the publications of the Geological Survey, including the above reports, which, with the exception of those marked as "out of print" can be purchased from Messrs. Dawson Bros., Montreal, or Messrs. Durie & Son, Ottawa.

Explorations in Southern New Brunswick.

GEOLOGICAL EXPLORATIONS.—In Southern New Brunswick, Professor L. W. Bailey and Mr. G. F. Matthew continued their investigations last season, assisted by Dr. Hunt. Their joint report mentioned last year, and which has now been further studied and revised, is presented with this. It forms a valuable contribution to our knowledge of the geological structure, distribution and relation of the formations in the region examined, and of which hitherto very little was known. The crumpled and faulted condition of the older rocks has rendered the correlation and identification of the different groups of strata in the several districts in which they have been examined, a labour of more than ordinary difficulty, and, therefore, some of the views expressed on these matters in the present report may possibly require modification when the investigation shall have been carried out in greater detail, with the aid of better topographical maps and over wider areas.

Explorations in Northern New Brunswick.

In Northern New Brunswick no further explorations were made last year. The accompanying report on a part of that region relates to explorations and surveys made by Mr. Charles Robb, in 1869, and is supplementary to that published in the Geology of Canada, Report of Progress, 1866-1869.

Exploration in Nova Scotia.

In Nova Scotia an examination and survey was commenced in September last year of the important coal district of Cape Breton and Spring Hill, Cumberland Co., Nova Scotia. This work was entrusted to the late Mr. Edward Hartley, assisted by Mr. Scott Barlow, and it had progressed satisfactorily up to the time when Mr Hartley was attacked by the severe illness which terminated in his death at Pictou, on the 10th November. As Mr. Hartley was not accompanied by Mr. Barlow to Cape Breton, I am unable to give any details respecting the investigations he made in that district. This is much to be regretted as I have no doubt his report, had he been spared, would have been most valuable and interesting.

Extracts from Mr. Hartley's correspondence

On the 2nd October he wrote from Cape Breton: "I am having a very interesting trip and accumulating quantities of information," and again on his return to Pictou 29th October: "My trip has been a capital success, and I have got many very interesting facts concerning Cape Breton especially. I had not the slightest conception of our resources until I saw the coal seams there. There are several seams in the series of from five to ten feet thick, and some of them are beautiful seams to work. They would pay enormously with a fair market, but the want of a market cripples everything. Some of the mines were only worked two and one half days last month."

The Smoke question.

He likewise alludes to certain economical questions as "of vital importance to our coal trade." He says, "The smoke question is even more important than I thought. I have got every coal manager interested in it. Mr. Lawson

adopted one of the suggestions in my last report, and put perforated flask plates on the doors of a set of his boilers; the consequence is that he only gets one sixth of the smoke from those altered (and very roughly) that he does from the old ones, and this is without the most important alteration, viz: putting an air plate behind the grate. I am satisfied that I could increase the trade 150,000 tons the first year after this became understood. I have been among the firemen and engineers of the steamers around the coast, and find them all ready to adopt my suggestions. They are mismanaging the coals fearfully, and they know it, but say they know no better way. Some of them have adopted my principles of management with great success. On the subject of coal cutting machinery and ventilation, he writes: "This is becoming of vast importance to us for this reason. Every mine which has been carried on to any considerable depth has met with gas fire damp, and ultimately they probably all will. The system of working thus far in these fiery mines is absurd. They use safety lamps, and yet they blast their coal. Surely it would seem there is as much danger of setting the gas on fire with the flame from a blast as from a naked lamp, and practice proves this is the case, and that most of the accidents from gas occur in this way. In England, where gas is expected or possible, coal-breaking machines are used, and of these there are a great many. Nothing of them is known in this country, only one having been imported, which Mr. Hudson is using in the the Foord Pit with very good success. It takes out the coal without shattering it as powder does. If coal breakers had been used two years ago, the Foord Pit explosion would have been prevented, and $15,000 or $20,000 saved, besides a year's shipping, perhaps 60,000 tons of coal. The Foord Pit has been put back eighteen months by an explosion and came very near being lost altogether. The day before yesterday I was at the pit when gas was struck and it came from the rock like high pressure steam from a boiler, making such a noise that you could not be heard speaking in a lond tone of voice. The Foster and Dalhousie Pits are closed. Two districts afire since June. The engine pits are crushed from the effects of an explosion, and the only pit among the five fine collieries which has men in the regular working places is the Cage Pit on the deep seam. What I have said of coal cutting machines applies also to ventilating machines. In England ventilation is a system. In this country, with very few exceptions, the mines may be said to be ventilated by the miraculous interposition of Providence, for very little is done by any one else. I saw one large mine worked without even a furnace; sometimes the air went one way sometimes another, and I was told '*It goes everywhere, wherever it likes; the coal is so pure that the men don't need air.*" My informant, who manages the mine, had actually driven a pair of levels 200 yards without a cross-cut for air. In England a man doing such a thing as the above would be liable to criminal prosecution under the Inspection Act. But there are no laws of the kind in this country, and every man does as he likes."

Coal-cutting machinery and ventilation.

Economy of Steam Colliers

Another question to which Mr. Hartley alludes, as deserving of serious consideration, is the economy of the employment of steam colliers in our coal trade. He says: "In England they are used with great success. We have all the inducements for their use that England has, and one or two more which I can name. Take the Cape Breton coast for example, where only six months' regular shipping is done. All the rest of the year the coal is banked, at a great loss. This short season is not due altogether to the fact that the harbours are closed in winter, for almost every mine can show shipments for every month in the year, providing that the harbour is not actually closed. The three principal reasons are, 1st. That the entrances are narrow and the channels rather intricate requiring particular winds to enable sailing vessels to make them. 2nd. Drift ice and fogs along the shore in the spring. Sailing vessels cannot get out of a floe of drift ice as a steamer can. They get into the ice in fogs and are carried out of their course. 3rd. The principal difficulty is the intense cold which freezes the running rigging of sailing vessels solid, so that the men cannot handle it at all. This is said to be a most serious difficulty. By the employment of steamers some of these difficulties would be overcome. A few have already been put on and are very successful, but it is impossible to get any facts here concerning their costs or expenditure during running time."

Geological structure.

Respecting the geological structure of the country he writes: "I have observed some very interesting things, and especially at one place. You will, perhaps, remember my supposition that Mr. H——'s syenite hill, which he said had grown up at New Campbelltown, near here, where the coal measures are vertical, might be Laurentian, brought up by a fault corresponding with Mr. Murray's fault in Newfoundland, which brings the Laurentian against the coal measures. I have just examined the locality and will give the fact, as briefly as possible. From Mire Bay to the Great Bras D'Or entrance, the coal measures dip generally east at very low and regular angles, showing some turns on east and west transverse synclinal axes, subordinate to the main north and south line in the Atlantic Ocean. At the south side of the Great Bras D'Or they show a north-west dip of from 5° to 10°, and turning dip at the north side about N. 80° E. < 17°. Now, in a quarter of a mile, they turn to a dip of S. 60° E. < 85°—90°, and even overturn. This is the dip of two seams at the New Campbelltown Mine, only about from 300 to 500 feet of the upper part of the measures being visible. The coal seams run, one of them perfectly straight, striking N. 40° E. dipping south-east 79° and overturning to 88°. This is a four foot seam and a drift driven across the measures cuts a lower seam of 6' at thirty-seven yards. Leaving the mine we go up a brook running down the side of the mountain where the section, well exposed, is as follows; the beds at 90° or thereabouts, and the brook running right across.

Four feet seam	4'
Metals, sandstone and shale	110
Six feet seam, oil shale and black fire-clay	9'

Measures concealed .... 100′
Limestone highly altered serpentinous and crystalline........... 150′
Syenite, &c., unknown.

"The syenite is pink, and is associated with hornblendic and granitic rocks, judging from the masses rolled from the hills, which I had not time to ascend. But the limestone is my great point. It is in some parts serpentinous, and one piece from the cliff it would be impossible to distinguish from some of the Petite Nation serpentinous limestones, from which the best Eozoon was obtained. A short distance west, two varieties are noticeable, a grey stratified variety (brownish grey with micaceous partings), and a perfectly white broadly crystalline, identical with typical specimens of Laurentian limestone. The carboniferous rocks can be observed within 50 or 60 feet of these limestones, one of the lowest is the band of 'oil shale,' or black slickensided under-clay, under the six feet seam. It is soft, and with a slight heat gives a gas burning with a bright carbonaceous flame. These are totally unaltered, and the coal, though it looks rather hard, is said to be a fair gas coal. Now, leaving the limestone entirely out of the question, had the syenite been intrusive, it certainly would have produced a local alteration in these carbonaceous beds, the shale and the coal. The rocks look exactly like Laurentian, of which serpentinous and broadly crystalline limestones, are, I believe, characteristic. Intrusive syenites do not generally bring up crystalline limestones. That it is a fault, admits of no question whatever. It is altogether the end of the coal-field, the seams are tilted vertically, and there is a total absence of everything representing lower part of Coal Measures, Millstone Grit, and lower carboniferous limestone, estimated by Mr. Brown at from 7,800 to 8,000 on Boularderie Island, right alongside the fault.

" Mr. Murray has a fault in Newfoundland, which would nearly hit this place, which brings the coal against the Laurentian, and he says the limestone is not very far below the coal, and that it does not require a great fault to bring it up. The Great Bras D'Or fault is possibly also so situated."

From the foregoing facts, it appears that the Coal Measures in Cape Breton are in direct contact with rocks of Laurentian Age, which, I believe, had not before been recognized as occurring in that region.

The Albert Mine.

In September, Mr. Hartley visited and examined the famous Albert Mine, in Hillsboro' County, N. B. In reference to the much disputed question, whether this remarkable deposit is a bed or a vein, Mr. Hartley says—" I have facts which prove beyond a question that it is a vein," thus confirming the view taken of it by Dr. Dawson, Professor Hind, and some other writers. Also, "It is the most interesting place I ever was in to study faults of all kinds, the slickenside grooves give them to you exactly. I had the opportunity of examining the face of the vein from the surface to

1,162 feet level. In some places there are faults in the upper level which do not shew below, and *vice versa.* When the old discussions alluded to were published, the mine was only 300 feet deep, and worked 300 feet on the strike; now it is 1,272 feet deep, and worked half a mile on the strike."

pring Hill.

In the Spring Hill coal-field, the survey commenced by Mr. Scott Barlow on the 6th of September, has progressed satisfactorily. The topographical work is based on the working plans of survey of two sections, Nos. 2 and 4 of the Intercolonial Railway, copies of which were obtained by Mr. Barlow through the kindness of Mr. Fleming, the Chief Engineer of the line, and of Mr. Henshaw, the Engineer in charge at Amherst.

Mr. John Anderson, the miner employed by the company interested in the "Black Areas" to trace out the crops of the seams through them properly, was instructed by the manager for the Company, Mr. Jas. S. Hickman, of Amherst, to shew Mr. Barlow all the trial pits sunk, and to give him sections of the measures in each, with any other information of value, and all the assistance he could in sinking other pits where thought necessary. At present the survey is not sufficientlv advanced to speak with any degree of certainty regarding the structure of the field or the extent, thickness and position of the several seams. The evidence so far as it goes appears to shew that in a distance of about eight hundred yards horizontal measurement across the strike of the measures, there are eight seams of workable thickness as under, in ascending order:

Number and thickness of Seams.

1	13	6	
2	6	0	
3	2	4	
4	12	3	
5	2	6	
6 a crop:	thickness uncertain.		
7	4	0	shaly coal.
8	2	0	
Total	42	7	

The average dip is supposed to be about 30°, which would give a vertical thickness of measures from the 13′ 6″ seam to the 2′ seam of about 1,200 feet. The dip increases as the seams are followed on their strike to the northward. The country is for the most part level and thickly forested, and the rocks are much obscured by drift, so that it becomes impossible to trace out the seams without the aid of pits and borings. The examination will be continued during the ensuing summer.

The greater part of my own time during the past summer was devoted

to observations in the gold districts of Nova Scotia, the results of which is given in the Report submitted herewith.

Mr. James Lowe has been engaged during the past season making measurements in continuation of the work of mapping the distribution of the various bands of crystalline limestone associated with the Laurentian rocks in the northern portions of the Counties of Argenteuil, Ottawa, and Terrebonne. These measurements are chiefly through unsurveyed lands on the upper waters of the rivers Rouge, North Petite Nation, St. Maurice, and Matawin. They comprise 167 miles of water, 18 miles of portages, and 46 miles of offsets, and have been plotted on a scale of two inches to one mile. It is not proposed to publish this work in its present form, but to include it in a map on a reduced scale, which will be prepared for publication to illustrate the distribution of the Laurentian limestones.

Laurentian rocks of Argenteuil, Ottawa and Terrebonne.

Between the rivers Rouge and Matawin Mr. Lowe states that there is abundance of land fit for settlement. The soil is a fine yellow loam, well suited for the cultivation of wheat, oats, corn, and root crops, as well as for hay. The land is likewise well adapted for grazing purposes.

Agricultural land.

The timber consists of maple, white and black birch of large size, and in the swamps, cedar, balsam, spruce, and some pines, though not generally large enough for lumber, also abundance of tamarack.

Timber

The outlet from this part of the country will be by the River du Nord and St. Jerome, on a circuitous course through hills of Laurentian rocks, but the land between the hills is well adapted for settlement.

East and west of the River Rouge, for an average breadth of two or three miles, the land is all fit for cultivation. On the River Maskinongé, a branch of the Rouge, excellent soil is found on the limestone bands, extending over fully 40,000 acres.

River Rouge.

The outlet from this district would be to Grenville, by a government road through the townships of Arundel and Harrington, on which a single team can draw from eight to nine hundred pounds, and a light car can travel from Grenville Village to the rear of the Township of Arundel without encountering any difficulties.

The Valley of the North Petite Nation River exceeds that of the Rouge because the limestone bands are much broader, and there is ten times as much good land as there is on the Matawin, or upwards of 400,000 acres. The soil is a similar yellow loam. It is likewise one of the best localities for the manufacture of potash in the Laurentian districts of the Counties of Ottawa and Terrebonne; the timber being maple, black birch, elm, ash, bass-wood, and pine in abundance, and large enough for lumber. There is a good road from the Village of Papineauville to Lake Simon or Barière, in the Township of Hartwell.

River North, Petite Nation.

On and near the limestone bands within the townships of Hartwell, Ripon, Ponsonby, Bidwell, Kilaly, and Preston, Mr. Lowe estimates that there are 100,000 acres of good land not yet surveyed. In the districts explored the rocks are exclusively of Laurentian Age, and consist chiefly of orthoclase gneiss with bands of crystalline limsetone. At a few points the occurrence of Labradorite was observed. Except the limestone, no minerals of economic value were met with.

Exploration of Mr. Richardson.

With a view of extending our knowledge of the character of the hitherto unexplored region to the west and north-west of Lake St. John, embracing the sources of the Saguenay, Rupert's River, the Nodway, the St. Maurice, and the Gatineau, and of defining the northern limits of the Laurentian System, and ascertaining the probable distribution and mineral characters of the newer formations in this northern region, Mr. James Richardson was instructed in June last to proceed to Lake St. John, where he had already, in 1857, made important investigations, and, if possible, to carry a connected line of observation thence to Lake Mistassini, including a survey and examination of as much of its shores as might be practicable.

Mr. Richardson left Lake St. John on the 2nd June, reached Lake Mistassini, 250 miles from Lake St. John, on the 5th of August, and after surveying about forty miles of what he describes as only one bay of this extensive sheet of water, he returned, crossing the head waters of the Nodway River, by the St. Maurice, and the south branch of the Gatineau to Ottawa, where he arrived on the 28th September, having completed a journey of 840 miles from Lake St. John. On the 26th of November last, I had the honour to submit a preliminary and condensed report of the results of this expedition, and I now beg to transmit Mr. Richardson's detailed report, together with a reduced copy of the map of the route, comprising about 290 miles of micrometer measurements.

Serpentines and Copper bearing strata

The discovery in this northern region of the occurrence of serpentines, fossiliferous limestones, and copper bearing strata, like those of the Quebec group is a fact of great geological interest, and one which may lead to important and unlooked for economic results ; making it exceedingly desirable to obtain further and more accurate knowledge of the extent and distributions of these rock formations in this new mineral region. It is, therefore, proposed to extend this exploration during the ensuing summer by endeavouring to define the limits of these copper bearing rocks, continuing the examination and survey of the shores of Lake Mistassini, and making observations in such other directions as time and circumstances may permit, especially along the height of land to the south-westward.

Explorations of Mr. Vennor

Mr. H. G. Vennor continued his labours last year in the same section of country to which his attention has been devoted during the previous four seasons. His report of the progress made in mapping the distribution of the

rock-formations, and of the valuable mineral deposits associated with them, I have the honour to transmit herewith, and likewise some important notes and observations made last season, in the same section of country, by Mr. Gordon F. Broome, F. G. S., on the apatite (phosphate of lime) and mica deposits. These notes would have been more complete had Mr. Broome not been prevented by illness from arranging them himself.

In the country north of Lake Superior further explorations have been made by Mr. Robert Bell. A preliminary report referring chiefly to the physical features of the district examined, has already been submitted, and Mr. Bell's detailed report is forwarded herewith. The exploration extended over an area measuring about 200 miles each way, and surveys were made of all the more important rivers and lakes within the area, partly in Ontario and partly in Rupert's Land, including the Pic River, Long Lake, the English River, White and Black Rivers, Notawasagawin Lake, and White Fish Lake. An examination was also made of the country between Long Lake and Lake Superior, and of the Slate Islands. Tracings of the plans of these surveys have been supplied for the use of the Department of Public Works. Explorations of Mr. Bell.

During the past year Dr. Hunt has devoted a portion of his time to the examination of the rocks of New Brunswick, in connection with Professor Bailey and Mr. Matthew; visiting also portions of Nova Scotia for the purpose of studying the rocks and of examining the ore deposits and the important iron works of Londonderry. He subsequently devoted considerable time to the study of various points connected with the iron and steel manufacture of the United States which it was considered desirable to investigate in connection with the iron resources of Canada; both as regards the prospective sale of our ores and the extension of the iron-manufacture in the Dominion. Later in the season he visited the salt region of Western Ontario, in order to continue investigations of the borings, and of the salt-manufacture already discussed at length in his report of 1869. In accordance with the suggestions there put forward, salt has, within the past year, been found as far southward as Warwick. His labors during the winter in the laboratory have been given to the examination of the various rocks, minerals, and ores collected by himself and the other officers of the survey during the year. Labors of Dr Hunt.

Mr. Billings has been engaged in examining various new collections of fossils, and in studying those of the older formations, principally those of the Lower Potsdam, from below Quebec, with a view to a general report on the so-called Primordial Fauna. Owing to the large number of new species, and the difficulty of determining them, this report will require another year's labour. It is highly desirable that additional collections should be made, and that several, at present undetermined, questions of great palæontological interest should be thoroughly investigated before publication. Among the questions here alluded to, the principal are the nature of *Eophyton*, and the determination of several new genera of Brachiopods and Trilobites. Investigations of Mr. Billings

Palæontological collections

The additions made to the palæontological branch of the Museum are important. The principal of these are the following :—

1. About 200 specimens from the Clinton and Medina formations, presented by Major C. Grant, of Hamilton, Ontario.

2. A collection of Devonian fossils from Moose River, made by James Anderson, Esq., Chief Factor of the Hudson's Bay Company, and presented by George Barnston, Esq. This collection is an important contribution, as from the remoteness of the locality it must always be difficult to obtain specimens which may throw any light on its geology.

3. About 100 species of beautifully preserved fossils from the Upper Silurian rocks of Gothland, Sweden. This collection is valuable for comparison. It was obtained in exchange from Dr. Gustav Lindstrom, of Gothland.

4. The skeleton of the fossil whale (*Beluga Vermontana*), discovered in a clay-pit at Cornwall. A full description of this skeleton will be given when the necessary means for comparison shall have been obtained. It was purchased from Mr. Chas. Pierce, of Cornwall, who is entitled to much credit for his exertions in preserving so valuable a specimen.

5. A collection of 500 good specimens of Devonian fossils from Cayuga, Ontario, obtained by purchase from Mr. F. De Cew.

6. A collection of Upper Silurian fossils from New Brunswick, made by Professor L. W. Bailey.

7. A collection of about forty species of Devonian plants, many of them very well preserved, from Professor L. W. Bailey, in exchange. They are all from the Devonian rocks of New Brunswick, and include many of the new species described by Dr. J. W. Dawson.

8. A collection of about thirty specimens of Eophyton from the primordial rocks of Saint John, New Brunswick, from Mr. G. F. Mathew.

9. A collection of Lower Silurian fossils made by Mr. James Richardson, at Lake St. John, containing a number of good specimens.

10. Mr. Weston has largely increased the collections of fossils from the Lower Potsdam rocks. There are now about sixty species known of this fauna, but as above stated it will require further collections in order to report satisfactorily upon them.

11. Among the most important additions are the specimens of Eophyton discovered in Nova Scotia at the Ovens Bluffs, on the Island of Orleans, near Quebec, and also at St. John, New Brunswick. Besides the above a number of minor additions, have been made to the collections, and in this respect the year has been one of more than usual success.

Arrangement of the Museum.

Much work has been done during the winter in the arrangement of the Museum. In the section devoted to economic mineralogy many specimens have been added, and instead of the printed labels hitherto attached to or accompanying the specimens, it has been thought desirable to mark all the objects, many hundred in number, with the name and locality written in oil

paint on the specimens themselves, or in some cases on the bottles containing them. This has required considerable time and labor, but will render the collections more convenient for the purposes of study, and obviate all risk of confusion from labels falling off, or the specimens being misplaced.

Economic Minerals.

To illustrate still further the uses of the economic materials, a space has been set apart for shewing the products of their chemical and metallurgical treatment. Among these will be found a series of specimens shewing the treatment of copper ores; also an instructive and pretty complete series illustrating the metallurgy of iron and steel, collected in the United States by Dr. Hunt.

Mineralogical specimens.

The collection illustrating the scientific mineralogy of the Dominion has been re-arranged, and augmented by the addition of specimens collected during the past two years. It is greatly to be regretted that there is not in the building a larger and better lighted space available for the display of the specimens required for the complete illustration of the mineralogy and lithology of the Dominion. This want is more especially felt since the extension of the field of the survey has so greatly augmented the materials at our disposal. A very large part of the collection available for this purpose is now necessarily kept in drawers out of sight, and consequently is not accessible to visitors for examination or study.

Among the specimens which have been added to the collections are—

1. A very fine example of the rich auriferous cross-lode discovered at Montague, Nova Scotia, in the Montague Mine, presented by the directors.

2. Three fine specimens presented by Mr. James Crossland, of gold with slate and mispickel from the Leary lead, Tangier, Nova Scotia.

3. Two specimens presented by Mr. Thomas McFarlane of the rich silver ore from Silver Island, Lake Superior.

4. A series of examples of the different seams of coal from the Pictou Coal field, Nova Scotia, collected by Mr. Edward Hartley.

I have the honor to be, Sir,
Your most obedient servant,
A. R. C. SELWYN.

List of Publications of the Geological Survey of Canada.

Publications of the Geological Survey.

1.	Report of	Progress	to 1843,	published	1845, 159 pages :	out of print.	
2.	do	do	for 1844,	do	1846, 110 pages :	French copies only.	
3.	do	do	1845,	do	1847, 125 pages :	out of print.	
4.	do	do	1846,	do	1847, 66	do	do
5.	do	do	1847,	do	1849, 165	do	do
6.	do	do	1848,	do	1849, 51	do	do
7.	do	do	1849,	do	1850, 115	do	do
8.	do	do	1850,	do	1852, 54	do	do
9.	do	do	1851,	do	1852, 131	do	do
10.	do	do	1852,	do	1854, 179	do	do
11.	do	do	1853, 54, 55, 56,	published	1857, 294 pages :	French copies only.	
12.	do	do	1857,	do	1858, 240	do	do
13.	do	do	1858,	do	1859, 263	do	do

14. Descriptive Catalogue of Economic Minerals and Crystalline Rocks of Canada, sent to the London Exhibition of 1862 : 88 pages.

15. Geology of Canada ; Report of Progress of the Geological Survey, from its commencement to 1863 : published 1863, 1,010 pages. In English and in French.

16. Notes on the Gold of Eastern Canada, extracted from the Geology of Canada : published 1864, 40 pages.

17. Atlas of six Maps and eighteen Sections to accompany the Geology of Canada, with an Introduction and Appendix, in which an analysis of all the Annual Reports is given, and explanations of the Maps and Sections : published 1865, 42 pages. In English and in French.

18. Reports of Progress, 1863-1866 : published 1867, 321 pages. In English and in French.

19. Reports on the Gold Region of the County of Hastings, by Dr. Hunt and Mr. Michel : published 1867, 11 pages.

20. Report on the Gold Regions of Nova Scotia, by Dr. Hunt and Mr. Michel : published 1868, 48 pages.

21. Summary Report of Progress, 1866-1869 : published 1869, 9 pages.

22. do do 1869–70 : published 1870, 14 pages.

23. Reports of Progress 1866-1869, with five Maps : published 1870, 475 pages. In English and in French.

24. Esquisse Géologique du Canada, with descriptive Catalogue, in French, of the Collections sent to the Paris Exhibition of 1867.

Descriptions of Canadian Organic Remains.

25. Decade I., Lower Silurian Fossils with ten plates : published 1859, 47 pages.

26. Decade II., Graptolites with twenty-four plates and numerous wood-cuts : published 1865, 151 pages.

27. Decade III., Lower Silurian Fossils with eleven plates and numerous wood cuts : published 1858, 102 pages.

28. Decade IV., Lower Silurian Fossils with ten plates and numerous wood-cuts : published 1859, 72 pages.

29. Palæozoic Fossils, with 401 wood-cuts : published 1865, 426 pages.

Maps.

30. Geological Map of Canada, and part of the United States, in eight sheets, scale 25 miles to one inch : published 1867.

31. Atlas of twenty folio Maps of various Rivers and Lakes to accompany the Report of Progress for 1853-56.

PRELIMINARY REPORT

ON THE

GEOLOGY OF SOUTHERN NEW BRUNSWICK,

BY

Prof. L. W. BAILEY, A.M.,

AND

GEORGE F. MATTHEW, Esq.,

ADDRESSED TO

A. R. C. SELWYN, Esq., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

PREFACE.

FREDERICTON, NEW BRUNSWICK, April, 1871.

SIR,—I have the honor to transmit to you, herewith, the Joint Report of Mr. Geo. F. Matthew and myself, on the Geology of southern New Brunswick, prepared in accordance with instructions communicated to me by Sir William Logan, late Director of the Geological Survey, in the month of April, 1868.

The area to which this Report relates, embraces the greater portion of the counties of St. John and Charlotte, with portions of the adjoining counties of King's, Queen's and Albert, or geologically, the metamorphic district extending from the boundary of Maine, along the northern side of the Bay of Fundy, and included between the latter and the great central coal basin of the Province. In the study of this region, the authors have, during portions of the summers of 1869 and 1870, been accompanied and assisted by Dr. T. Sterry Hunt, to whose long experience and extended knowledge of metamorphic regions they are greatly indebted. Region examined.

Instructions. Having been enjoined by Sir William Logan to make the geological structure of the region committed to us the principal part of our work, our labors have been chiefly directed to that end. Owing, however, to the difficulty attending the examination of the structure of so complicated a region, replete as it is with numerous great faults and over-laps, it has been found necessary to study its geology in a general way at first, before entering upon a more accurate and detailed examination. The following Report embraces the substance of these preliminary observations on the geological structure of southern New Brunswick, and remarks on the economical geology of that portion of the Province, so far as observed by us.

Summary of earlier investigations. The Geology of New Brunswick having now for the first time come within the province of the Geological Survey of Canada, it has further been deemed expedient to reproduce here, somewhat fully, the results already obtained by earlier observers in this district. Such a revision is accordingly incorporated with the results more recently obtained, and the whole made to embody, as far as possible, the knowledge which we now possess of the geological structure of the region in question.

It may be proper to state here, that although large portions of the district to which this Report relates, have been examined both by Mr. Matthew and myself, other large areas have been more particularly studied by the one or the other; such examinations, however, having been in all cases followed by a careful comparison of the facts ascertained, with a view to a harmony of results and the attainment of reliable conclusions. To Mr. Matthew's skill and long familiarity with some of the more difficult and complicated regions thus considered, the Survey is largely indebted. To the same gentleman I would here express my own sense of obligation for much friendly counsel and assistance during the several years in which we have together studied the geology of this interesting region.

Acknowledgements for assistance. I desire, in conclusion, to express here our united obligations to several gentlemen, by whom our labors have been facilitated; more especially to Mr. Chas. Robb, for assistance in draughting plans for field-work; to Mr. Henry Frye, of St. George, for valuable information and assistance in the study of the region about Passamaquoddy Bay, as well as for permission and aid in gathering interesting suites of fossils from Cailiff (or Frye's) Island; to Capt. J. P. Robson, of Musquash, for information and aid in the exploration of the Musquash Rivers; and to Dr. Dibblee, of Moore's Mills, for similar services in the vicinity of the latter place. We would also return our thanks to the Provincial Secretary of New Brunswick, and the Superintendents of the European and North American and the St. Andrew's and Quebec Railways, for free passes and other accomodations on their respective routes.

I have the honor to be, Sir,

Your obedient servant,

L. W. BAILEY.

GEOLOGY

OF

SOUTHERN NEW BRUNSWICK.

INTRODUCTION.

THE District to which the following observations refer is for the most part embraced in the more southerly portions of the Province of New Brunswick, including the greater part of the counties of Charlotte, St. John, King's, and Queen's, and constituting the hilly and metamorphic region lying between the Bay of Fundy and the great central basin of the Province. Region examined.

TOPOGRAPHICAL FEATURES.

The principal topographical features of this region may be described as consisting of a series of ridges of moderate elevation, having, with their included valleys, a course a few degrees north of east, or approximately parallel to the Bay of Fundy. These ridges, however, are not continuous throughout the district, but present a series of overlapping lines which, from a slight divergence between their course and that of the coast, are found, in travelling westwardly, to gradually and successively approach the latter. Topographical features.

The most marked of this series of elevations is a tolerably regular and persistent belt, composed of highly crystalline and granitoid rocks, which, entering the Province from Washington County, Maine, extends with but little interruption through the central parts of Charlotte, to the St. John River in Queen's County, and again eastward of the latter to the north-eastern part of King's County. Almost everywhere rising above the level of the surrounding formations, this chain of highlands constitutes a striking feature in the scenery of the southern counties. Diversified by numerous lakes of greater or less extent, it serves to form, especially in its central portions, the watershed between the streams which drain the central basin, and those which, like the Musquash and New Rivers, flow southward into the Bay of Fundy. It is, however, traversed by several large streams, such as the St. John, Magaguadavic, Digdequash, and St. Croix, which, through tranverse valleys, find their way from lakes lying northward of the crystalline belt, more or less directly to the sea. Highlands of Charlotte, King's and Queen's Counties.

No accurate measurements of the height of any parts of this chain have Elevation.

yet been taken. It is, however, probably the most elevated as well as one of the most rugged ranges of southern New Brunswick. When viewed from a distance, its outline is gently undulating, but where cut by transverse valleys, as among the Nerepis Hills, and on the New, Magaguadavic and St. Croix Rivers, it often presents escarpments of a bold and abrupt character. The central and southern portions of the chain, rising into sharp hills often nearly bare, or encumbered with coarse surface-drift and large granitic boulders, afford but little opportunity for cultivation. On its northward side, however, the soils are less meagre and more productive, sustaining several good settlements.

Character.

Northern slate belt.

The region which lies northward of the crystalline belt just noticed, between the latter and the coal-field, is comparatively low, and exhibits much less diversity in its surface features. Largely composed of slates, often soft and readily removed by denudation, it seldom rises into prominent hills, presenting usually the aspect of a level or gently undulating plateau. Near the crystalline belt it is somewhat broken, in several instances rising into hills of moderate elevation, among which Flume Ridge, Pleasant Ridge, and Mount Pleasant may be mentioned as the most marked; but northward, near the coal-field, it is for the most part low, and its scenery monotonous. Extensive peat-bogs and swamps abound within this portion of the region, from which flow numerous tributaries of the larger rivers which traverse its area. Where not too thin, the soils of this district are good, and many fine settlements are included within its limits.

Maritime western belt.

Between the great crystalline belt first noticed and the coast, there is, in the region lying westward of the St. John River, to which the above description is intended chiefly to apply, no similar ridge of a marked or persistent character. Embracing, however, a large number of geological formations, usually greatly disturbed, and rocks very varied in composition and texture, it has been remarkably affected by denuding agencies, and now presents features of a very irregular and diversified character. In some portions high and broken, in others it is comparatively low; its hill-ranges, though conforming to the general trend of the coast and the high lands of the interior, are not unfrequently cut by narrow transverse valleys, having usually a nearly north and south course (magnetic); while the coast itself, indented with innumerable bays and inlets, confers still greater diversity upon the surface features of the district. Watered by many minor streams, it is also traversed by the larger rivers above noted, nearly all of which, after a more or less rapid descent, and broken by numerous cascades, enter the sea by long fiord-like estuaries, These latter constitute so distinguishing a feature of this portion of the coast as to suggest a community of origin, and, with the valleys above alluded to, seem to mark an area of extensive glacial denudation. The numberless islands which skirt the coast, and through which the formations of the main land may be traced more or less continuously, may be in part a result of the same agency,

though also largely due to removal by the powerful tidal currents of the Bay of Fundy, a process at some points still in rapid operation.

Capacity for settlement.

Varied in its geological as in its topographical features, this maritime tract affords soils of very unequal character. Though in some parts capable of cultivation, it is in others hopelessly barren, and except where water-power gives facilities for the timber trade, contains few settlements. In some parts presenting only bare flat rocks, and in others extensive bogs and sandy barrens, while over large areas is spread a coarse covering of drift, the district, as a whole, is for agricultural purposes one of the least promising in the Province.

Eastern maritime tract.

While presenting some features of resemblance to those of the district just described, the region which occupies a similar position eastward of the St. John River is of simpler and at the same time more marked topographical character. Besides the ridge above alluded to as forming in King's County the direct continuation of the great central crystalline belt of Charlotte and Queen's Counties, which has its eastern termination at Butternut Ridge, three other ranges of hills form prominent features in the topography of this portion of the Province. Of these the most northerly traverses the central portion of King's County, and constituting the peninsula of Kingston, extends eastwardly with slight interruption beyond Sussex ; between this and the ridge first mentioned is included the Long Reach, a lake-like expansion of the St. John River, together with its extension in the Belleisle Valley and that of the Millstream in Studholm. The second is parallel to the last, and, forming the high land in the parish of Portland, extends eastwardly beyond the Hammond River to Campbell Lake in the parish of Sussex. Between this and the Kingston ridge is the remarkable depression of the Kennebecasis Bay and River, with a depth of from one hundred to two hundred feet below tide-level in its western portion, where it unites with the valley of the St. John, but much shallower eastward, in which direction it forms a broad and open valley connected by transverse depressions with that of the Belleisle.

Long Reach and Belleisle Valley.

Kennebecasis Valley.

Loch Lomond Valley.

The valley occupied by Loch Lomond and its associated lakes, and the upper half of the Hammond River Valley, separate the Portland Ridge from another, the most elevated in this portion of the Province, which, skirting the Bay of Fundy, constitutes the hilly and broken region in the eastern part of St. John and Albert Counties. Near St. John, this ridge, terminating at Cape Spencer, rises in the eminence called Bloomsbury Mountain. Thence extending easterly it embraces the Quaco Hills between Loch Lomond and the coast. It comprises nearly the whole of the parish of St. Martin's in St. John County, and much of those of Upham and Sussex in King's. Still farther east it traverses Albert County in two or more parallel ridges, terminating in Caledonia and Shepody Mountains. This range, like the crystalline belt in Charlotte and Queen's Counties, embraces several minor and subordinate ridges, and constitutes the water-shed of numerous streams, of

Quaco Hills.

Caledonia and Shepody Mts.

Rivers. which the principal on the northern side are the Hammond River, flowing westwardly into the St. John, and the Pollett and Coverdale, tributaries of the Petitcodiac; and on the south, Black River, Quaco River, Salmon River, and others, for the most part broken streams descending rapidly towards the Bay of Fundy. The coast along this portion of the Province is frequently bold and high, and much less indented than that already described westward of St. John.

Soils. The soils of this eastern metamorphic district present much variety. Those of the highlands above described, resting upon crystalline rocks, are for the most part meagre, though many portions support a vigorous forest growth; some tracts, especially near the coast in St. John County, present features similar to those of the corresponding regions west of St. John, being covered by bare ledges of sandstone or extensive sphagnous swamps; but where less altered sediments prevail, as in the valleys of the Belleisle, Kennebecasis, Hammond River, and Petitcodiac River, soils of a much more productive character are to be found. The fertility of these soils is greatly increased by the large amount of calcareous matter derived from the limestone and gypsum beds so abundant in the region, and in the valleys alluded to are to be found some of the richest agricultural districts in the Province.

The peculiarities of the several districts above described, both topographical and agricultural, are partly dependent upon their geological structure, and in part upon the influences to which they have been subjected in later epochs of their history. The consideration of the latter may be deferred until a systematic review of the entire surface-geology of the region is presented. We proceed to an enumeration of its more important geological features, prefixing thereto a brief synopsis of what has already been done in this region by earlier observers.

GEOLOGICAL FEATURES.

Labors of Dr. A. Gesner, 1838-1843. The first published observations on the geology of New Brunswick were those of Dr. Abraham Gesner, who, between the years 1838 and 1843, made a geological survey of the Province, and by whom five reports, embodying the results of this exploration, were submitted to the Provincial Legislature.

Reports. Of these reports, the first treats of the southern border of the Province from St. Stephen to St. John, including the islands of Passamaquoddy Bay, and of the country along the western side of the river St. John as far north as the border of the New Brunswick coal-field. The second describes the coast eastward from the St. John River to the Petitcodiac River, the interior valleys of King's and Westmoreland Counties, and the eastern and southern parts of the latter County. The third treats of a re-examination of the region described in the second report, and includes also that portion of Queen's County east and south of Grand Lake. The fourth report is devoted to a description of a part of the region treated of in the first; of the tract along the western

border from St. Stephen to Woodstock; of the country on both sides of the river St. John from Woodstock to Fredericton; and of the coal-field from Boiestown to the mouth of the Miramichi River, and on the principal rivers in Kent County. The fifth report, which is both topographical and geological, describes in a general way the northern part of the Province, namely, that part of it which lies north of a line drawn from Woodstock to Bathurst.

In these publications Dr. Gesner described the more obvious features in the geology of New Brunswick, giving many details of the topographical and agricultural characters in its different portions, and succeeded in effecting a partial subdivision of its formations. Two great masses of intrusive granitic rocks were found to traverse the Province. Of these, the more northerly was traced from the Cheputnecticook Lakes on the western frontier, to the Keswick River in York County. A supposed continuation of it was found to form the high hills at the sources of the Nepisiquit and Tobique Rivers. The second great ridge of intrusive rock was also found to enter New Brunswick from the state of Maine, at Calais and St. Stephen. It was described as extending thence eastward, nearly to the Petitcodiac River in Westmorland County. Both of these belts of crystalline rocks were referred to as primary, and as being flanked on both sides by schistose beds of Cambrian age. These were described as consisting of slates of various colors, and grauwacke or fine grained sandstone, and were said to rest upon the slopes of the granitic ranges. North-westward of the more northerly of these two great granitic ridges a large area was found to be covered by clay-slates, more or less calcareous, and holding beds of limestone. This group of sediments, which was observed both on the river St. John and along the shores of Bay Chaleur, was, on the evidence of its organic remains, referred to the Upper Silurian period.

Results.

Granites.

Cambrian rocks.

Calcareous slates.

In the geology of the southern metamorphic district Dr. Gesner encountered much greater complexities in the relations of the rock-formations. He found the great granitic ridge extending across the southern part of the Province, to be composed of two belts of igneous rocks, diverse in character; the more northerly consisted of true granite, containing mica, and extended from the Cheputnecticook River and Lakes to the St. John River, opposite the entrance of Belleisle Bay. The second belt, which lay along the southern side of the last, is described as covering an extensive tract in the western part of Charlotte County, and passing through that County to the St. John River in King's County; whence it extended along the western side of this river to the entrance of Belleisle Bay, and crossing at this point into the Peninsula of Kingston, passed onward through the eastern part of St. John County to Shepody Mountain, where it terminated. The rocks of this belt were spoken of as consisting largely of syenite and trap, and as having burst through, and in places overflowed, the schistose strata to the south of them. Elsewhere the

Granite.

Syenite and trap.

granitic and syenitic belts are described collectively as a range of granitic and trappean mountains, running from the Chamcook hills, near St. Andrew's in Charlotte County, to Bull Moose Hill, in the parish of Springfield, in King's County.

Greywacke system.

South of these great masses of intrusive rocks, two groups of strata, both pertaining to the "greywacke system," were said to cross the outlet of the St. John River. The *lowermost* of these groups comprised limestone beds (resting directly upon the syenite), and clay-slates. This group was referred to the Silurian system on the evidence of a "*terebratulite*" figured at page 8 of the second report. The *terebratulite* was found in a zone of slates in the parish of Portland, which has, of late years, yielded a primordial fauna, and may have been a badly distorted *Orthisina*. This shell is said to have been also met with in the limestones. These calcareous beds were traced eastward to Hammond River, beyond which they were wanting. West of the St. John River, however, at several points in the counties of St. John and Charlotte, other limestones were found which were referred to this group. The *upper* group, consisting of greywacke and greywacke-slate, contained "trunks of trees," which were evidently those of the Dadoxylon sandstone, in the parish of Simonds.

Fossils.

"Primary" rocks of Black River.

Still another group of altered rocks, consisting of micaceous, chloritic and talcose schists, with sandstones, conglomerates and trap-beds, was recognized in the neighborhood of Mispec Harbor and Black River, which, from the evidences of apparent unconformability to the two above named, and the absence of organic remains, was pronounced, in relation to them, to be "primary." No division of the schistose strata westward of St. John was attempted by Dr. Gesner, they being designated, collectively, as the greywacke system or transition series.

Non-crystalline rocks.

It will be observed that the more southerly belts of intrusive igneous rocks, thus recognized by Dr. Gesner as stretching across the Province, correspond approximately to the great ridges alluded to in our remarks on its topographical features. In the valleys and plains intervening between these ridges, and partly covering their slopes, non-crystalline rocks were found, consisting, for the most part, of sandstones and conglomerates, with some beds of shale. In the largest of these depressed tracts, namely, that contained between the converging ridges of the two more northerly belts, (the one extending from the Cheputnecticook Lakes towards Bathurst, and the other from St. John to Springfield in King's County), these rocks were found to be usually of a grey color, and not unfrequently to contain remains of plants and seams of coal. They were, on this account, correctly referred to the Carboniferous period, and were shown to occupy most of the great central plain of the Province—a triangular area having its apex near the Oromocto Lake, and its base along the Gulf of St. Lawrence. This coal-field was found to include much of the Counties of York, Sunbury, Queen's, Northumberland,

Carboniferous.

Kent and Westmorland, connecting in the latter with the coal-fields of Nova Scotia. The largest of the coal seams observed in this area was that of Grand Lake in Queen's County, measuring twenty-two inches in thickness. **Coal seams.**

Around the border of the coal-field and near its centre, sandstones of a bright red color were found to occur, and occasionally beds of limestone. These limestones, which are fossiliferous, were correctly referred to the base of the Carboniferous system. The red sandstones, however, except those crossing the St. John River at Hampstead, were supposed to be of more recent origin, and with similar beds, which were found to occupy much of the valleys of the Belleisle, Kennebecasis and Petitcodiac Rivers, (where they were also associated with limestones, together with gypsum beds and saline springs,) were termed the New Red Sandstone formation, while the red sediments of Hampstead were classed as Old Red Sandstone. A study by Sir Charles Lyell, of the similar group in Nova Scotia, subsequently led to a determination of the true position of these sandstones and associated calcareous and gypsiferous beds, they being near the base of the Carboniferous system. Deposits of New Red Sandstone were also recognized by Dr. Gesner along the coast of the Bay of Fundy, and on the Tobique River, in the northern part of the Province. **Red sandstones.** **Supposed age.**

At page 4, of his fourth report, Dr. Gesner expresses his intention of presenting with that report a Geological Map of New Brunswick, embracing the results obtained up to the end of the year 1841. No such illustration of Dr. Gesner's work is now known, but there is a large manuscript map, enlarged from one compiled under the direction of the Hon. John Simcoe Saunders, formerly Surveyor-General of New Brunswick, now in the possession of the directors of the Mechanics' Institute, of St. John. This map has been colored in accordance with the geological views of Dr. Gesner, but only represents the ground covered by his first three reports. It is highly probable that this map was prepared by him, and may have been the one referred to in his fourth report. In some respects it is more accurate than the one subsequently put forth by Dr. James Robb, of King's College, Fredericton; as, for instance, in the outlines of the granitic belt extending from St. Stephen to Hampstead, on the St. John River; and in the fact that the sandstones, slates, etc., along the south side of the syenitic and trappean belt, near the Bay of Fundy, which Dr. Robb subsequently colored as Upper Silurian, were called by Gesner the greywacke system, in "part Silurian." **Geological Map of Dr. Gesner, 1841.**

The map published by Dr. Robb, which was the first published geological map of the Province, having been issued in 1850, with the report of Prof. J. F. W. Johnston on the agricultural capabilities of New Brunswick, was based upon the data obtained by Dr. Gesner, corrected and supplemented by Dr. Robb's own observations during the six years succeeding the completion of Dr. Gesner's survey. In it considerable progress was made in distinguishing both the limits and character of the several groups. The outlines assigned to these formations, which were described as to a **Map of Dr. Robb, 1850.**

great extent conjectural, coincide, for the most part, with the descriptions given in Dr. Gesner's report. In presenting this map, however, Dr. Robb made two very important observations; first, that most of the red colored sandstones, with and without gypsum, which Dr. Gesner had supposed to be newer than the coal formation, were really below the productive coal-measures, being probably of the age of the Mountain Limestone, or perhaps Devonian; and, secondly, that a great part of St. John, King's and Queen's Counties, described by Dr. Gesner as trappean, was, in reality, largely composed of slates, though much altered and disturbed by igneous action. In the same report in which these observations were made, a more concise and accurate description of the coal-field is given by Dr. Robb, with especial reference to its productive capacity, and correcting the greatly exaggerated views previously entertained.

Observations of Dr. Robb.

The later labors of Dr. Robb would probably, if published, have added much information upon the geology of New Brunswick; but, in the absence of further publications, great uncertainty continued to be felt with reference both to the age and position of the formations, more particularly in the southern portion of the Province, and it was not until the year 1861 that the study of the rocks in the neighborhood of the city of St. John, by affording a basis of comparison, began to throw a more certain light upon the geology of this little understood region. The study was begun and prosecuted chiefly by Mr. G. F. Matthew and Mr. C. F. Hartt (the former one of the authors of the present report), through whose labors a separation of the sediments about the city of St. John into several distinct groups was effected, one of them being characterized by a well-marked fossil flora. The first description of these groups was presented by Dr. Dawson, in a paper "On the Precarboniferous Flora of New Brunswick, Maine, and Eastern Canada," (Canadian Naturalist, May, 1861), in which, also, the age of the plant-bearing strata was referred to as probably Upper Devonian. In a subsequent paper, by the same author, "On the Flora of the Devonian Period in North-eastern America," (Quarterly Journal of the Geological Society, London, 1862), a fuller analysis of the entire series is presented. The strata were divided into eight principal groups, and full descriptions of the fossil plants contained in the upper beds were given. These, constituting Nos. 2 and 3, were described as consisting for the most part of grey and dark grey shales, flags and sandstones, overlaid by coarse fragmental beds (No. 1) of red, purplish and greenish colors, and resting upon similar coarse beds of reddish color, associated with trappean and tufaceous rocks (No. 4). The collective thickness of these groups, based upon approximate estimates of Mr. Matthew, was given as 7,200 feet. Beneath these were found 400 feet of fine dark colored shales, with layers of cone-in-cone concretions (No. 5), and 3,000 feet or more of hard grey, somewhat micaceous shales and flags, containing lingulæ, worm-burrows, and tracks of animals. These constituted

Labors of G. F. Matthew and C. F. Hartt, 1851.

Labors of Dr. Dawson.

Devonian rocks.

group 6; No. 7 was described as consisting of white and grey crystalline limestones, etc., 600 feet or more in thickness, beneath which was an unknown thickness of gneissose and metamorphic beds, with bands of quartzite and slate. No definite age was assigned to the deposits underlying the plant-beds, but it was supposed that they might belong either to the Lower Devonian or the Silurian. Many details of these several groups are contained in the articles referred to, together with several sections constructed by Mr. Matthew. Older formations.

In the year 1863, the gentleman last named, in an article entitled "Observations on the Geology of St. John County, N. B." (Canadian Naturalist, August, 1863), after a more minute investigation of the deposits referred to, made a partial recasting of the groups of Dr. Dawson, substituting local names for the numbers previously employed, and giving many additional particulars of the character and distribution of the several formations, with a geological map of the vicinity of St. John, and an accompanying section. As this paper has been to a great extent the basis of subsequent exploration in this region, it is here reproduced :— G. F. Matthew, 1863. Recasting of formations.

PORTLAND SERIES. (Nos. 7 and 8 of Dawson), thickness unknown. Granite and syenite, mica-schist and gneiss, limestones, clay-slates and sandstones. Fossils : fragments of plants in the upper beds.

COLDBROOK GROUP. (No. 6 of Dawson, in part), thickness 3,000 feet or more.

a. Greenish-grey slate, stratification very obscure.

b. Bright red slaty conglomerate and dark red sandy shale.

c. Reddish conglomerate and grit, hard grey sandstone.

ST. JOHN GROUP. (Nos. 5 and 6 of Dawson, in part); thickness, 3,000 feet or more. Several zones of soft black and dark grey finely laminated shales, alternating with zones of coarser grey slates, containing numerous thin beds of fine grained sandstone. Fossils: *Lingula*, a conchifer, annelids, coprolites.

BLOOMSBURY GROUP. (No. 4 of Dawson). Thickness, 2,500 feet.

a. Basalt, amygdaloid, trap-ash, trap-ash slate; some beds of conglomerate. Thickness, 2,000 feet.

b. Fine grained red clay-slate; reddish-grey conglomerate. Thickness, 500 feet.

LITTLE RIVER GROUP. (Nos. 2 and 3 of Dawson). Thickness, 5,200 feet.

a. "Dadoxylon sandstone"; grey sandstone and grit, with dark grey shales, sometimes graphitic. Thickness, 2,800 feet. Fossils: numerous plants, several crustaceans, wings of insects, etc.

b. "Cordaite shales"; grey, greenish and red shales; reddish and grey sandstones, grits and conglomerates, alternating with the shales. Thickness, 2,400 feet. Fossils: *Cordaites*, *Calamites*,

Stigmaria, ferns, etc., for the most part identical with those of the preceding section.

? Granulite or granitic sandstone, micaceous slate, trap-ash.

MISPECK GROUP. (No. 1, of Dawson). Thickness, 1,800 feet.

a. Coarse sub-angular conglomerate.

b. Fine grained purple clay-slate and grits, surmounted by slate-conglomerate.

? Red and green slate, basalt (stratified)?

Additional observations.

The above synopsis is based upon the appearances presented by these different groups in the immediate vicinity of St. John, and for a short distance to the eastward, in the direction of Black River. Besides many topographical and geological details of this district, a partial synopsis of the Carboniferous formation, as seen in the Kennebecasis Valley and upon the coast, was at the same time presented, two divisions being recognized, viz. : (1) a lower, consisting of coarse red conglomerates, red sandstones and red shales, containing Algæ and stems of land-plants, and (2) an upper, comprising grey sandstones and grey and brown shales, the latter containing characteristic Lower Carboniferous forms. These Carboniferous beds were found to lie unconformably over the higher members of the Devonian series, as well as over the inferior groups, and to be themselves overlaid at one point by bright red sandstones, holding fragments of coniferous wood, referred to the New Red Sandstone period.

Prof. Bailey 1864.

In the same year in which the above cited paper of Mr. Matthew appeared, a some what cursory examination of the condition of the mining industries of the Province was made by Prof. Bailey, on behalf of the Lieutenant-Governor. In the report of these observations "on the Mines and Minerals of New Brunswick" (Fredericton, 1864), no attempt at investigating the geological structure of the region was made, but in a paper entitled "Notes on the Geology and Botany of New Brunswick" (Canadian Naturalist, 1864), some facts were presented bearing upon the geological structure of the northern portion of the province, obtained during a canoe-exploration of the Tobique and Nepisiguit Rivers. These streams were found to have their origin among a high range of hills, composed in part of red granulitic and feldspathic rocks, and in part of a grey syenitic gneiss, the Tobique flowing thence through a country occupied chiefly by calciferous slates, probably of Upper Silurian age, and covered by a considerable outlier of red gypsiferous sandstones of the Carboniferous period; while the Nepisiguit, flowing south-easterly, was also found to traverse a district of slaty rocks, probably older than those last mentioned, but of an uncertain age. These slates, near the town of Bathurst, were described as resting upon the flanks of granitic ridges, which were supposed to be continuous, as represented in the geological map of Dr. Robb, with those of York County and the Maine frontier.

In the following year, the author of the papers last cited having been commissioned by the Provincial Government to carry on the work of geological exploration, the study of the southern metamorphic district was resumed. In association with Messrs. Matthew and Hartt, a *reconnaissance* of the country lying eastward of St. John and near the coast was effected, and further information obtained as to the character and distribution of the several groups previously recognized near that city. Of these groups, the "Portland" was found to extend eastward for some distance beyond the mouth of the Hammond River; the "Coldbrook" and "St. John" groups to be of much wider distribution, the former extending eastward towards Albert County, and for some distance including the latter within a synclinal fold; while overlying these Coldbrook rocks, the Devonian sediments and their supposed equivalents in a metamorphic form were found to be widely distributed. Carboniferous and Lower Carboniferous beds were at the same time distinguished at several points along the coast, as well as in the great basin of the Kennebecasis and Petitcodiac Rivers, and the existence of the New Red Sandstone formation at several localities confirmed. **Bailey, Matthew & Hartt, 1865.**

One very important result of the explorations referred to was the discovery of a well-characterized fauna in the dark shales near the base of the St. John group. Trilobites had been previously observed in rocks of this formation, and unconformability between this and the Devonian series suspected; but it was not until an examination of the fossils obtained at this time had been made by Prof. Hartt, that the age of these rocks was definitely fixed as being Primordial, and as representing a Silurian horizon lower than had previously been recognized in America. A preliminary notice of this remarkable fauna first appeared in the report of the survey now under consideration. By establishing a new horizon, the relations of the associated beds became more evident, and the probable Eozoic age of the underlying Portland and Coldbrook rocks was suggested, the former being regarded as probably Laurentian, and the latter as Huronian. These conclusions appeared to be confirmed by the general lithological characters of the groups referred to. **Fossils in St John group.** **Probable Eozoic rocks**

In the same report, but as the result for the most part of the personal observations of its author, additional information was given as to the nature and relations of the formations further inland, over much of King's County, as well as over portions of Charlotte, Queen's and York Counties. A band of rocks, consisting to a great extent of pale grey gneisses, felsites and slates, associated with considerable masses of interstratfied diorite, and characterized by the frequent occurrence of chlorite and epidote, was distinguished as occupying much of the peninsula between the Kennebecasis and the Long Reach of the St. John River, extending eastwardly towards Sussex, and connected probably in a westerly direction, with similar rocks observed by Mr. Matthew about New River in Charlotte County. This belt was

4

described under the provisional name of the Kingston series, and, mainly on the ground of lithological resemblance to the rocks in the Upper Silurian hills of Nova Scotia, together with the occurrence of fossils of that age at Frye's Island, in the probable extension of these beds, was doubtfully referred to the latter horizon. With these Kingston rocks was associated, with some hesitation, a series of sediments distributed along the north side of the Long Reach of the St. John River, and thence extending eastwardly through the parishes of Kars and Springfield towards Butternut Ridge. These latter were found to present much diversity, and, though described with the Kingston rocks as probably Upper Silurian, the resemblance borne by some portions of the series to the schistose rocks along the eastern coast of St. John County was at the same time commented on.

Kingston series.

Granites of Queen's County.

The schistose rocks, thus provisionally associated with the Kingston series, were found to rest in the valley of the Nerepis River, upon the southern flank of the great granitic belt pointed out by Dr. Gesner as extending through this region from the state of Maine to the St. John River at Hampstead. Some comparisons of these crystalline rocks with those of the great granitic belt of York County were instituted, and on the ground of their relations to the surrounding stratified series, and their resemblance in this respect to the granites of Nova Scotia, (which, according to Dr. Dawson, penetrate the Upper Silurian and Lower Devonian formations of that Province,) were looked upon as having been probably intruded at or towards the close of the Devonian age. The series of schistose rocks, recognized by Dr. Gesner as lying along the northern flank of this crystalline belt, was at the same time found to consist (as seen at Hampstead and other points farther west), to a great extent of slates, usually highly micaceous, and their thickness was estimated at about five thousand feet. These slates, bordering the coal-basin on the south, were supposed to be somewhat older than those of the Kingston series, and under the designation of the "Mica-schist formation" were compared with those which, on the northern side of the coal-basin, extend through the county of York into the state of Maine. From those of Queen's County, however, the latter were found to differ in being less micaceous, and in the occurrence with the slates of numerous intercalated beds of fine grained sandstone or quartzite, in these features more nearly resembling the rocks of Primordial age in and near the city of St. John. These slates and quartzites of York County were described as resting upon the great central crystalline belt of the same county, and with the latter, were supposed to be continuous across the Province, from the frontier of Maine to the Bay of Chaleurs, near Bathurst, as previously represented in the map of Dr. Robb.

Mica-schists.

Slates, etc., of York County.

Work of Mr. Hartt

In addition to the observations above noted, the report under consideration embraced a general view of the Carboniferous basin; a minute synopsis by Mr. C. F. Hartt of the Devonian plant beds of Lancaster, St. John County, together with a list, by the same writer, of the fossils of New Brunswick; and finally

notes on the topographical features, agricultural capabilities and useful minerals of the several formations. A map and several sections, illustrating the structure of the southern metamorphic region, accompanied this report. Simultaneously with its publication, a summary of the results therein contained, with some additional facts and general remarks, was published by Mr. Matthew in the Quarterly Journal of the Geological Society of London (November, 1865), in a paper on "The Azoic and Palæozoic rocks of Southern New Brunswick."

Map and Sections.

Paper by Mr. Matthew, 1865.

In the same year (1865), Prof. H. Y. Hind, under the direction of the Provincial Government, submitted to the Legislature a "Preliminary Report on the Geology of New Brunswick, together with a Special Report on the Distribution of the Quebec Group in the Province." To the latter horizon were referred, on lithological and stratigraphical grounds, two great belts of schistose rocks previously described as Cambrian by Drs. Gesner and Robb, and already noticed as traversing the central portion of the Province on either side of the granite ridge of York County. Details of the distribution of these slates and granites, tending to show the existence of several parallel belts of the latter, were furnished by Prof. Hind, together with some observations on the supposed Upper Silurian rocks of the Tobique and Upsalquitch Rivers.

Prof. H. Y. Hind, 1865.

Supposed Quebec rocks.

So much had been accomplished in the study of the geological structure of New Brunswick, when, in the year 1868, there appeared a second edition of the Acadian Geology of Dr. J. W. Dawson. Combining the results obtained by the different observers whose labors have been mentioned above, this work, so far as regards the geology of New Brunswick, may be considered as embracing the extent of our knowledge prior to the commencement of the work of the present survey. Besides containing in a condensed form the results of previous investigation, this edition of the Acadian Geology acquired a special interest and value as presenting for the first time a full and elaborate synopsis of the remarkable fossil flora of the Devonian period, and the no less remarkable fauna of the Primordial period disclosed in the schistose beds in the vicinity of the city of St. John.

Acadian Geology. 2nd Ed. 1868.

A new and beautifully executed geological map of the Provinces of Nova Scotia, New Brunswick and Prince Edward Island accompanied this second edition of the work of Dr. Dawson.

Map.

The observations which follow are for the most part based upon the results obtained by the authors during their exploration of the southwestern counties in the summer of 1868, and portions of the summers of 1869 and 1870. With these, however, is combined a summary of our present knowledge of the character and distribution of the same formations as previously studied to the east of the St. John River; while both are supplemented and corrected by the observations of Dr. T. Sterry Hunt, made in connection with one of the authors during portions of the two last seasons mentioned above.

The following geological formations are believed to be represented within

Series of formations.

the area to which these observations refer, and are described in the succeeding pages in the order in which they are here enumerated :

Laurentian (including rocks similar in mineral composition to those of the Labrador Series), and an Upper Series connected therewith.
Huronian.
Lower Silurian—(St. John Group.)
Upper Silurian.
Devonian.
Intrusive Granite.
Perry Group.
Lower Carboniferous.
Carboniferous (or Coal Measures.)
Triassic, or New Red Sandstone.

In addition to the above formations, of which the age may be considered as established, there are also several large groups of strata, the position of which is not yet fixed. These are the mica-schists of Charlotte County, the Mascarene series of the same county, and the Pre-carboniferous rocks north of the granite hills in Queen's and Charlotte Counties. They are described immediately after those divisions to which they appear to bear the nearest resemblance.

THE LAURENTIAN SYSTEM.

Original description.

The existence in southern New Brunswick of rocks older than those of the Silurian series, and probably equivalent to the great Laurentian system of Canada, was first asserted by us in the year 1865; the highly metamorphic strata which occupy the parish of Portland, and appear to underlie the dark slates and quartzites of the neighboring city of St. John, being at that time referred to this horizon, in consequence of the discovery in an overlying series of fossils characteristic of the Primordial Zone, as well as on account of a general resemblance in lithological characters between these more ancient rocks and those of the Laurentian system. The strata in question were found to consist to a great extent of granitic and syenitic gneiss, associated, however, with a great mass of crystalline limestones, with silicious and graphitic beds,

the whole apparently constituting one series, and separated from the primordial beds by an accumulation of trappean and tufaceous* strata, which were supposed to be of Huronian age.

This ancient assemblage of altered rocks, first described by Mr. Matthew under the name of the Portland group, was in the year above named shown to occupy a belt of land about forty miles in length, and from two to eight in width, lying to the north and north-east of St. John, constituting a somewhat elevated and broken tract of country, overlaid to the south by Huronian, Primordial and Devonian strata, and on the north by Upper Silurian and Carboniferous sediments. Besides forming much of the Narrows of the St. John River, this series was described as including the greater portion of the country lying westward of this stream—about South Bay and the peninsula of Pisarinco--and as thence extending westwardly towards the county of Charlotte. Distribution in St. John Co.

In addition to the tracts referred to in earlier publications, several other areas have since been recognized, in which the lithological characters of the strata exhibit so many features recalling those of the supposed Laurentian rocks in St. John County, that we are inclined to refer them to the same ancient system. The largest of these areas is to be seen in the western part of Charlotte County, where it appears to constitute much of the high land north of Passamaquoddy Bay, and, though partly covered with later sediments, is connected with an area of similar rocks near the towns of Calais and St. Stephen. A second region, in which such strata are met with, includes portions of the parishes of Petersville and Hampstead in Queen's County, and that of Springfield in King's county. Other areas.

The rocks in the Laurentian area near the city of St. John are arranged in three principal belts, in each of which the constituent masses of sediment have characters which distinguish them from those in either of the others.

The more northern of these belts, which is also the more extensive, and apparently the oldest, consists chiefly of compact fine-grained granite and gneiss, with very obscure lamination. The rocks in this tract are mostly of a gray color, varying to red when there is much orthoclase feldspar, and to shades of green when hornblende is abundant. They have been observed on both sides of the St. John River, near its mouth, whence they extend eastwardly into the parish of Sussex, in King's County, and westwardly Arrangement in St. John Co. northern belt.

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*At the date of the publications referred to, the aspect of these Huronian rocks was looked upon as indicating a volcanic or semi-volcanic origin. Dr. Hunt, however, who has recently examined them, is of opinion that most of the rocks which we have designated as tufaceous, or composed of trap-ash etc., and which are fine grained dioritic and petrosilicious sediments, are probably not of volcanic origin, but result from peculiar conditions of deposition. This remark will apply to most of the rocks described under such names in our previous publications.

through the northern part of the parish of Lancaster to Musquash village and Lepreau Harbor, in Charlotte County. At several points along the northern edge of this belt of rocks, as at Long Island, in Kennebecasis Bay, and near Quispamsis Station on the European and North American railway, there are limestone beds of considerable thickness, which rest upon the gneiss. These dip to the northward, but whether they are contained in the gneiss, or represent the great limestone beds on the southern side of it, has not been ascertained.

Second belt.

The next great belt of rocks in this supposed Laurentian area consists chiefly of crystalline limestones and quartzites, with silicious beds of gray and black colors. Along its northern side it rests upon the great gneissic band above mentioned, but at its southern margin it is divided from the third belt of Laurentian rocks by a line of fault at those points where the contact of the two groups has been observed. This limestone and quartzite formation extends from Menzies Lake, in the parish of Lancaster, St. John County, on the west, to and beyond Hammond River, in the parish of Hampton, King's County, on the east. Its relations to the two great masses of Laurentian rocks which flank it on either side are not yet clearly understood. It bears much resemblance in the nature of its sediments to the strata of the upper series (Div. 5, 6 and 7 below) of the third belt of rocks in the area under consideration; but it has not yet been ascertained whether the several groups of limestone, mica-schist, quartzite, &c., in each, correspond in aspect, thickness and position.

Third belt.

The third belt of rocks, just mentioned, is better known, both as regards its structure, component parts and relations to the overlying Huronian and Silurian sediments. The main divisions of it are as follows:—

	FEET.
LOWER SERIES:	
1. Gray gneiss, some portions of which enclose masses of darker gray gneiss, often two feet or more in diameter. The thickness of this mass is unknown, as it is cut off by a fault at its contact with the great body of limestone and quartzite to the northward of it, but it is probably equal to the aggregate thickness of the two following divisions.	
2. Reddish-gray gneiss, with much red orthoclase feldspar	1,500
3. Dark gray gneiss, mostly with gray or greenish triclinic feldspar, with beds of syenite and coarse diorite containing disseminated magnetic and titaniferous iron	1,000
4. Gray granitoid chloritic gneiss, with little or no mica (not recognized east of Musquash.)	
UPPER SERIES:	
5. Dark gray limestone and cream-colored dolomite, with patches of pale green serpentine; and schistose chloritic gneiss	260
6. Gray quartzite, gray rusty-weathering quartzose gneiss and mica-schist, and dark gray diorite	

		FEET.
7.	Gray and dark gray limestone and gray (rusty and gray-weathering) argillite, both alternating with beds of fine dark gray diorite and black graphitic shale	700

The strata of this third belt of crystalline rocks may be well seen in the lower portion of the Narrows of the St. John River at and below Indiantown, and at the Straight Shore in Portland. The lower gneissic portions of the group re-appear to the westward along the road from Spruce Lake to Musquash, while the limestones and the quartzites of the upper series are well exposed on the eastern shore of the peninsula of Pisarinco. Both portions cross the latter to Musquash Harbor, of which they form the eastern shore. On the west of that indentation they are represented only by narrow ridges extending south-westwardly towards the coast; the intervals between the ridges being occupied by Devonian(?) sediments.

We may here remark that the area to which the foregoing descriptions apply, embraces all to which the name of the Portland group has been assigned in earlier publications. Beyond this district, to the westward, near the coast, we have failed to recognize any rocks which are probably referable to the Laurentian system, unless such be the age of certain beds occurring on Frye's Island, L'Etang Peninsula, and in the headlands of Mace's Bay, which correspond in appearance with Divisions 5 and 6 of the above synopsis. At L'Etang there are limestones and quartzites, and on Frye's Island principally limestones, these including magnesian as well as ordinary limestones, and in some parts holding considerable quantities of a pale green translucent compact idocrase, which has been mistaken for serpentine. These beds resemble the series of rocks near the Suspension Bridge over the St. John River, and those of Pisarinco Cove and Musquash Harbor. Southern Charlotte

It has been stated that in addition to the areas already noticed, large tracts of country, composed of rocks apparently referable to the system under consideration, have been observed at several points farther inland, in Charlotte, Queen's, and King's Counties. These rocks, which are generally granitic and sometimes gneissoid, have in all previous descriptions and maps of the region in question, been confounded with the very dissimilar granites of the Nerepis Hills, and have been represented as forming with the latter a belt of nearly uniform width, stretching from the western frontier to the St. John River, in Queen's County. Closer examination, however, of this granitic belt has revealed much diversity in its characters, and made it evident that crystalline rocks at least two types are represented among its members. Of these, one approximates in character to the Laurentian rocks, the other is composed of intrusive granites.

The largest of the areas occupied by rocks of Laurentian aspect is that of south-western Charlotte County, an extensive broken tract of country lying for the most part north of Passamaquoddy Bay. Besides covering a Central and western Charlotte.

large part of the parishes of St. Andrew's and St. Patrick—the northern boundary from Waweig Bay and River on the west, to beyond the Clarence-Hill Settlement on the east, while that on the south extends from the St. Croix River, below the bay last named, nearly to the falls at the mouth of the Digdequash River—several smaller areas of similar rocks have been observed to the westward, about St. Stephen, Calais, Milltown, and Baring, and north-east of the first-named town, on the Dennis stream. The gneissic rocks are in these various areas surrounded and partly covered by mica-schists, quartzites and argillites of uncertain age, to be presently described, through which they rise in several small detached islets.

Characters. The rocks supposed to be of Laurentian age in the districts of which the limits have just been given, though remarkably uniform over large areas, exhibit, nevertheless, some diversity. They are everywhere crystalline and granitoid, but while true granitic gneisses are sometimes seen, they are usually of limited extent, the prevailing rocks being a syenitic gneiss and diorite. In color, they are usually some shade of dark gray or green, but with these are sometimes associated lighter colored beds, as on the St. Andrew's railway, at Oak Point on the St. Croix River, and elsewhere. Granites or syenites with red and flesh-colored feldspars are occasionally seen over the area occupied by these rocks, and about the Upper Bocabec Lakes appear to be of considerable extent; these appear to be bosses of intrusive granite, which is abundant, both to the east and west of the district now under consideration. In texture, also, the supposed Laurentian rocks of southwestern Charlotte are somewhat various, being in some parts fine and even-grained, with an evident lamination, while in others they are coarsely crystalline and porphyroid. At several points, as about Milltown and Baring, and near the Roix Station, on the St. Andrew's and Quebec railway, these gneisses present the appearance of numerous large irregular masses or boulders of fine texture and dark gray color, enclosed in a light gray granitoid and porphyritic matrix. So abundant are these enclosed masses, and so irregular and diversified their shape, as often to present the appearance of a network of light gray veins in a darker colored rock. In some portions, however, a bedded structure is more apparent, and at one point a light gray granitoid and porphyritic gneiss was observed, in which, besides dark syenitic masses, a distinct pebble of conglomerate was contained. We cannot doubt that much of the rock under consideration is stratified, but among these altered and crystalline sediments it is highly possible that granites of eruptive origin may also be included.

Stratified diorite. Just north of the town of St. Stephen, and occupying a position between the syenitic gneiss of the latter, and the mica-schists and quartzites which appear to overlie them, are limited outcrops of dioritic rock which differ in many respects from any strata that we have met with elsewhere. These are of a very dark, almost black, color, with a very evident and regular

Serpentine. stratification, often including thin layers of dark green serpentine, while in

the mass of the rock, besides white feldspar and hornblende—the latter predominating—crystalline masses of diallage are occasionally met with. These rocks, which have been examined *in situ* by Dr. Hunt, and by whom the serpentines have been found to yield both chrome and nickel, are apparently connected with the underlying syenitic gneiss rather than with the schistose rocks which succeed them to the northward.

Too little is yet known of the relations and composition of the rocks of Charlotte County just considered, to institute comparisons between them and the members of the Laurentian system in St. John County. It may, however, be noted that limestones which occur, though sparingly, in the lower series of Laurentian rocks of St. John county, have not yet been met with in the gneissic tract of western Charlotte. **Comparison with rocks of St. John Co.**

It has been stated that in the latter district the gray gneisses are sometimes associated with reddish granitic rocks, which are supposed to be similar to those which constitute the high hills about the Nerepis River. Between the Digdequash and that stream, these reddish rocks were the only granites observed, but in tracing the crystalline belt eastward of the Nerepis, dark syenitic rocks are again met with in the broken country north of the Long Reach of the St. John River, and are well exposed in the parishes of Petersville and Hampstead, in Queen's County. Where first seen in Petersville, they consist of coarse grained syenitic and dioritic rock, associated with dark olive-gray micaceous quartzites, but at Hampstead, where they have been quarried for many years, the rock is a fine and even grained gray granite, consisting of whitish orthoclase, quartz, and black mica. Within the gray rock are contained numerous dark colored blotches, some of which are unmistakeably pebbles, of hornblendic gneiss and hornblende rock, recalling the similar appearances in the rocks of St. Stephen and Baring, to which, in other features also, that of Hampstead bears much resemblance. **Queen's Co. syenites and granite.**

Where the St. John River crosses the belt of crystalline rocks under consideration these are abruptly cut off, the eastern side of the stream presenting only schistose rocks of Huronian and Silurian ages. About fourteen miles further east, however, crystalline rocks similar to those described above again appear at the surface near the Scotch Kirk in the parish of Springfield, whence they extend eastwardly, with an average width of about one mile, nearly, if not quite, to the parish of Studholm. The greater portion of this belt consists of coarsely crystalline diorite and syenite, through which magnetic or titanic iron is disseminated in grains and occasionally in veins, much as in some portions of the similar rock in Hampstead and Petersville in Queen's County, and in the area about Bocabec Bay, in Charlotte County; but with these, true granites, of gray and reddish tints, are also sometimes met with, forming veins (and beds ?), and at one point enclosing numerous large angular fragments of the darker dioritic rock. **Springfield, King's Co.**

Albert Co.

We may conclude these general remarks with a brief reference to the central portion of Albert County, where crystalline rocks bearing some resemblance to those of the Laurentian system have also been observed. Such rocks here appear to form two or more parallel ridges covered in part by schistose rocks, probably of Huronian age. Near Elgin these crystalline rocks are granitic, of a light reddish color, consisting of quartz, pale red feldspar, and a soft green mineral, probably a hydrous mica; while on Prosser Brook, a tributary of the Coverdale River, farther east, and at Caledonia Mountain, they are chloritic and syenitic gneisses, associated, and at the first named locality, interstratified with schistose petrosilicous rocks and diorite. Granitoid and gneissic rocks, somewhat similar to the above in aspect, also appear farther south at some points along the Shepody Road, especially near where the latter passes from St. John into Albert county. They may be in part intrusive.

DETAILS OF THE LAURENTIAN SYSTEM.

The general range and distribution of the supposed Laurentian rocks in St. John County have been already given. The most complete succession of these sediments is displayed on the rocky shore of the St. John River, especially about the suburb of Indiantown. As the beds here are well exposed, and afford the most satisfactory data for the determination of their age, we propose to describe them with some minuteness. Near the locality last named we have made the following section, which will serve to show the nature and succession of the deposits, as well as the data from which their approximate thickness has been deduced. The section is an ascending one, from Spar Cove, above Indiantown, on the left bank of the St. John River, to the Straight Shore in the parish of Portland.

Indiantown section.

	Traverse meeasure. FEET
Division 1:	
Dark grey diorite and syenite	100
Dark grey gneiss, with much hornblende, and without obvious stratification	250
Division 2:	
Coarse red porphyritic granitoid gneiss, without obvious marks of stratification.	250
Reddish-grey granitic gneiss, coarsely crystalline, without obvious marks of stratification. (South side of Spar Cove)	350
Reddish-grey gneiss, with pale red orthoclase feldspar	750
Division 3:	
Dark grey gneiss, partly syenitic	250
Dark greenish-grey hornblendic gneiss, with greenish-grey ieldspar ...	100
Dark greenish-grey hornblendic gneiss and greenish-grey gneiss ...	250
Dark grey chloritic gneiss	100
Grey silicious gneiss	200
Greenish-grey, coarsely crystalline syenitic gneiss or syenite, portions of which contain magnetic iron ore	170

Division 4:	
[This division is wanting here. See page 31.]	
Division 5:	
Measures concealed. Fragments of variegated limestone and diorite occur in the interval	110
Greenish-grey gneiss, partly chloritic	25
Grey crystalline limestone and cream colored dolomite	120
Dark grey graphitic argillite, and grey buff-weathering argillite ...	10
Division 6: Thickness about 450 feet.	
Grey rusty-weathering quartzose gneiss	50
Grey quartzite	26
Grey rusty-weathering quartzose gneiss	23
Grey quartzite	16
Grey rusty-weathering quartzose gneiss	75
Measures concealed	45
Grey rusty-weathering hornblendic quartzose gneiss	167
Grey quartzite	23
Grey rusty-weathering quartzose gneiss, with some hornblende ...	20
Grey quartzite	12
Division 7: Whole thickness about 670 feet.	
Grey and dark olive-grey silicious argillite, the two colors often in thin alternating layers, with one or more beds of dark grey fine grained diorite	145
Dark grey crystalline limestone ; dip 90°	95
Measures concealed	32
Hard rusty-weathering olive-gray argillites, with disseminated pyrites and one or two beds of dark fine grained diorite	100
Grey crystalline limestone	14
Hard grey rusty-weathering argillite with disseminated pyrites, and having black graphitic beds at the top	70
Break in section	45
Grey rusty-weathering quartzite and silicious diorite, both with disseminated pyrites ; graphitic slate	50
Space with measures partly concealed. About six feet of dark grey crystalline limestone on the upper side	15
Dark grey fine grained rusty-weathering diorite, with disseminated pyrites	38
Grey crystalline limestone, bluish-grey in the lower part	30
Dark grey rusty-weathering fine grained diorite, partly schistose ...	17
Bluish-grey limestones, with layers of impure graphite at the summit.	42
Measures concealed	50
	4,235

Primordial slates of the St. John group.

The rocks first named in the above section form the shore on the north side of Spar Cove, just above Indiantown, where they are met by a body of grey and dark grey limestones, grey quartzites, and dark grey or black petrosilicious beds of the great calcareo-silicious formation in the middle of the Laurentian area. The broken and abrupt character of the cliffs Spar Cove.

along this portion of the Narrows is such as to render the attainment of exact measurements impossible, but the following would appear to be the general succession going northward, between Spar Cove and the Boar's Head at the mouth of Kennebecasis Bay.

Narrows of St. John River, East side.

Quartzite, silicious slate and fine grained diorite, meeting the red granitic gneiss of the last section.

Limestone and diorite.

Grey calcareous and earthy conglomerate, holding angular limestone pebbles in a paste which is either dioritic or silicious; the lower part alternating with calcareous and dioritic seams, becoming more uniform and passing into an impure limestone.

Blue and white limestones, the latter sometimes crystalline, and the former with seams and beds of fine grained diorite.

Syenite.

Limestones and quartzites alternating with dark grey diorite.

Fine white limestone, sometimes veined with red.

Grey, dark grey, and greyish-black (graphitic) limestones, with greyish-black and greenish diorite in dykes and beds. Some of the limestones are slaty.

Dull red and green quartzites and diorites.

Grey slaty limestones.

The above series forms the shore from Spar Cove to Glen Cove, a little more than a mile above Indiantown, from which point to the Boar's Head the older rocks are unconformably covered by nearly horizontal Lower Carboniferous conglomerates. Throughout the series the succession is much obscured by faults and folds.

West side.

The same general succession as that detailed in the section last given may also be observed on the western shore of the river, but with several changes in the relative position and magnitude of the beds, especially in the greatly increased surface area occupied by the red and grey syenite and granite corresponding to the similar stratified rocks of Indiantown. From these latter, moreover, that on the opposite side of the river differs in being coarsely crystalline, and the red in being markedly porphyroid, with crystals of orthoclase feldspar. This granite is not distinguishable from much of the intrusive granite of the Nerepis Hills. Its area, however, is quite limited.

Upper series.

The rocks which we have designated as the Upper series in the Laurentian area, extend through the suburb of Portland and form the north side of the ridge separating the upper falls and rapids from the Straight Shore and harbor. They cross the main river at and above the Suspension bridge which, on the eastern side, rests upon a projecting point of primordial slates, underlaid on the north by less than fifty feet of Huronian rocks, which here overlie limestones and graphitic beds of the Upper series; on the west it is supported mainly by Huronian beds, associated, however, as

before, with limestones of the Upper series beneath, and to the northward of the bridge by conglomerates and slates of the Primordial series in a cove just south of the latter. The strata on the east side of the river are thrown, with reference to those on the west, about fifty feet to the southward. There are numerous minor faults of from four to five feet.

Falls of St. John. Between the lower rapids, beyond the limestones above noted, and the lime-kilns near the oil-works, the only rocks exposed on this side of the river are at Union Point, near the upper fall or rapid, where beds of ferrugiuons gneiss and quartzite, representing Division 5 of the section, appear. Near the oil-works these are followed by calcareous beds, and the latter in turn by hornblendic, syenitic and granitic gneiss and granite. (Divisions 1, 2, and 3). These gneissic and granitic rocks have a surface breadth of nearly one-third of a mile, and form the greater portion of the high land on the right shore of the Narrows as far as Langley's mill. Between this mill and the oil-works we have made the following ascending section.

Section on west side of Narrows.

	Traverse measure.
Divisions 1, 2 and 3:	FEET
Ferruginous quartzite and fine grained gneiss	50
Buff and grey coarse grained limestone	25
[Across the east end of these limestones is a fault by which the granite mentioned below has been carried 300 feet to the northward].	
Grey gneiss, partly pyritous. Dip N. 30° W. < 80°	120
Grey and buff coarse grained limestone, holding fragments of silicious beds. Dip S. 30° E. < 80°	100
[On the shore of the Narrows and east of the line of section, the same beds appear at Quarry Cove, dipping S. 30° E. < 50°. They are here highly crystalline, some of the beds being filled with scales of yellow mica, whilst others hold fragments of quartzose layers twisted and doubled upon themselves.]	
Red and grey syenitic granite, showing in places traces of stratification	1,700
Grey syenitic gneiss	50
Reddish syenitic gneiss	50
Grey hornblendic gneiss	10
Division 5:	
Greenish fine grained diorite, with thin seams of reddish or rose colored and white crystalline limestone, much contorted	50
Blue limestone, with thin layers of fine bluish-green diorite, much contorted	50
Hard blue and cream colored fine grained dolomite, breaking into small angular fragments	170

Green Head Peninsula. The granitoid rocks which form the bulk of the above section appear at many points upon the Green Head road, a short distance to the north-west. Some portions here represented are without visible stratification, while others exhibit a gneissic structure, and are succeeded at Mosquito

Cove Hollow by well marked gneiss. The latter, which here seems to follow immediately upon the granitic portion, is found to differ in some respects from the corresponding beds on the south side of the same. It is hornblendic, and in portions is seamed with harder quartzose layers, apparently conforming to the bedding, which is greatly contorted. Other portions enclose granitic boulders from six to twelve inches across, showing it to be in part an altered conglomerate, while, like the granite on the south, it is occasionally penetrated by dykes of intrusive rock resembling dolerite. Owing to dislocations and possible repetitions, its true thickness is uncertain, the surface breadth in traverse measure being about 4,500 feet, of which the first 3,500 are granitic, followed by 300 feet of the quartzose variety (in part conglomerate), and by feldspathic and hornblendic gneiss, with some blanks, which may possibly be occupied by limestones.

The gneiss last named is cut by a fault running east and west, and is then followed by grey limestones, having a thickness of about one hundred and fifty feet, conforming in strike to the course of the fault, and dipping N. < 80°. These limestones, which are a part of the great calcareo-silicious series forming the central belt in the supposed Laurentian area of St. John and King's Counties, may be traced eastward in a low ridge to the shore of the Narrows on the north side of Mosquito Cove, opposite Langley's mill, the dip in this direction changing to S. 30° E. < 80°. The Laurentian gneiss here re-appears on the shore, with a dip S. 60° E. < 80°, the most northerly point in this vicinity at which the latter has been observed. Beyond the first named rock, on the north side of a neck opposite Langley's mill, a grey calcareous conglomerate, consisting of a grey feldspathic paste holding limestone pebbles succeeds, and conforms to the limestone beds above mentioned both in dip and strike.

Returning to the Green Head road, the section was extended in a northerly direction over the calcareo-silicious strata in the centre of the Laurentian area, as follows :—

Section on Green Head road.

	Traverse measure. FEET
Space, occupied mostly by slate-conglomerate and dark blue slaty limestones	170
[On the shore eastward, at a cove opposite Langley's Mill, these beds appear as follows: dark grey slaty limestone, dip S. 65° W. < 70°, 30 feet; dioritic rock, partly slaty, 10 feet; dark grey limestone, 100 feet; calcareous conglomerate with limestone pebbles, 200 feet. This conglomerate is probably the same as that already noted on the east side of the river above Indiantown.]	
Fine grained schistose dioritic rock	130
Quartzite and fine grained schistose rock	100
Grey and dark grey limestone	200
White limestone, slaty in part, with dioritic beds	200

Measures concealed	50
Fine grained silicious and dioritic rock	100
Blue limestones, partly obscured, and perhaps repeated by faulting ...	250
Fine grained white crystalline limestone	150
Schistose, argillaceous and silicious rocks. Dip S. < 50°	340
Silicious conglomerate, with pebbles of black slaty silicious rock and limestone; paste calcareous and silicious	250
Limestones, in part white fine grained and crystalline, in part dark grey	350
Thin banded argillaceous? and silicious schistose beds, dipping S. < 70°	600
Silicious beds (with some limestone near the base) mostly finely laminated, with beds and dykes of diorite...	460
Dark grey limestone, cut by a ten-foot dyke of diorite	150
Measures concealed	100
Schistose silicious rock. Dip S. 20° E. < 50°	250
Limestones. Dip S. 20° E. < 50°	250

Many of the beds above enumerated are exposed along the river's edge on the west side of the Narrows. At Swift Point are pale grey and white crystalline limestones, with a conglomerate composed of limestone pebbles in a base of serpentine, the whole dipping S. 10° E. < 80°; and at Deadman's Cove, on the east side, very coarsely sparry grey and dark grey banded limestones with sharp folds, dipping S. 20° E. <40°. At the Green Head quarry appear the dark grey limestones of the section, exposing a vertical wall of 100 feet. A short distance around and beyond the point, which forms the upper end of the Narrows on this side, are beds of limestone exposing, over a surface nearly ten feet square, large numbers of concentric nodular masses, bearing much resemblance to some genera of corals, but apparently destitute of organic structure, and probably concretionary. Narrows, West side.

We have been somewat prolix in describing the structure of the rock-formations of the Narrows, as the beds are better displayed there than elsewhere, and may serve to explain the structure of the same formations as seen in the districts east and west of the St. John River, and in other portions of the Province.

In the district immediately eastward of that just described, the gneissic and calcareous strata may be observed at many points in the parish of Portland, with features essentially the same as those above given. Upon the Narrows, as previously stated, the width of the belt of these rocks is somewhat reduced by overlying Lower Carboniferous deposits, which also cover the older rocks for some distance along the south shore of Kennebecasis Bay; but these reappear in several islands of the latter, and again upon the mainland, about Sand Point, beyond which they may be traced towards Rothesay, and thence along the line of the railway toward the Hammond River. At several points along the shores of Kennebecasis Bay, there occurs with the calcareo-silicious strata of the central belt, a series of schistose beds, containing trilobites and other primordial fossils, the relations of which to the older series Kennebecasis.

Drury's Cove. are not yet clearly understood. At Sand Point and Drury's Cove, where the succession is best seen, these Primordial beds, consisting of grey argillaceous shales and very hard silicious shales with lenticular calcareous patches, are apparently overlaid, first by coarse greenish and reddish syenitic rocks (the lower portion of which, adjoining the slates, holds rounded and angular pebbles of quartz and silicious shales), and secondly by grey and dark grey limestones. The entire absence of such syenitic and calcareous strata in the Primordial series at St. John, is opposed to the view that these appertain to the latter group, and renders it probable that we have here a fault by which the beds of the calcareo-silicious series have been made to overlie rocks really much more recent. Primordial shales, more arenaceous than the last, with *Lingula* and other fossils, occur upon Long and Kennebecasis Islands, resting upon reddish and greenish syenitic gneiss, and overlaid by Lower Carboniferous conglomerates. In connection with the gneisses on Long Island there are extensive beds of fine grained white and grey crystalline limestone. Eastward of the island they are concealed by the waters of Kennebecasis Bay, and on the mainland by Lower Carboniferous deposits, except at Coleman's limestone quarry, near Quispamsis station, where they have been exposed to view by the denudation of the more recent series.

Fault

From Grand Bay on the St. John River, to Torryburn Cove, the great belt of gneisses extending along the north side of the Laurentian area is mostly concealed by the waters of Kennebecasis Bay. Detatched exposures of rocks, however, belonging to this belt, appear at various points and islands along its shore, as on Kennebecasis Island and Barlow's Bluff, where the strata are chiefly greenish-grey and red chloritic gneiss, and on the neck of land west of Torryburn Cove, where red and pale grey gneiss or granite come into view. From this cove to Salmon Creek, the eastern shore of Kennebecasis Bay, here called Rothesay Bay, is bordered by this band of gneissic rock. Between the shores of this bay and Hammond River, they appear at intervals in the valley of Salmon Creek and on the Westmoreland road. Beyond the Hammond River they may be seen in the ridge dividing that stream from the Kennebecasis, and are exposed in detached hills as far east as Campbell's or De Forest Lake, in the parish of Sussex.

Torryburn.

Rothesay.

The central band of limestones and quartzites has not been traced by us farther eastward than the depression between Kennebecasis Bay and the Westmoreland Road, but the limestones which occur in the Laurentian hills south of Nauwigewauk, on the European and North American railway, probably pertain to this belt. The southern band of gneisses extends along the Westmoreland road nearly to the Hammond River, where they are covered by the Lower Carboniferous series. The associated limestones and quartzose mica-schists, however, do not appear further east than Coldbrook Factory, being overlaid at that point by Huronian rocks.

Westmoreland Road.

In connection with the gneissic band last mentioned, several hills of crystalline feldspar rock, associated with hypersthene, and in some cases with magnetic iron, are found about seven miles east of the city of St. John, running with a northeasterly course along the north side of Dolin's Lake, and traceable for a mile in the same direction across the Westmoreland road These rocks have been examined *in situ* by Dr. T. Sterry Hunt. He considers them to be identical with some varieties of the norites or anorthic feldspar rocks of the Labrador (Upper Laurentian) series, and is disposed to refer them to that horizon. They present several varieties, the most marked being a hypersthenic norite or anortholite, consisting of labradorite and hypersthene, the latter not unfrequently in large cleavable crystals, sometimes two inches or more in diameter; in other portions of the mass, this hypersthene is replaced by pyroxene, producing a diabase.

Dolin's Lake.

Norite rocks.

On the north side these anortholite rocks are met by red gneiss and granite, similar to the Laurentian strata at Indiantown, and on the south are covered by conglomerates and diorites of the Huronian series. Towards the summit of the hill near Dolin's Lake, they are divided by heavy dykes of dark grey diorite.

Red gneiss.

While the area occupied by the rocks of Laurentian aspect to the eastward of the St. John River is thus limited, that in which rocks of a similar kind occur to the westward of that stream is much more considerable, their northern limit being a line extending from the river last named, near the boundary line between St. John and King's Counties, southwestwardly to Lepreau Harbor; while that of the south is more irregular, being nearly parallel to the above from the Suspension bridge to the mouth of Musquash Harbor, but beyond the latter indented by Huronian and Devonian sediments, which lie in depressions of the older gneiss. Through the greater part of this area the rocks are the dark grey and reddish-grey granitoid gneisses of divisions 1, 2, and 3, but the limestones and quartzites of Divisions 5 and 6 are largely developed along its southern border about Pisarinco and Musquash Harbor; while in the centre of the Laurentian tract, another belt of limestones and quartzites occurs, being a continuation of those of the Narrows of the St. John River, and of the Green Head peninsula. These have considerable width on the west side of South Bay, but are narrower in the interior, and have not been seen westward of Menzies Lake.

Laurentian rocks west of St. John R.

The character of the supposed Laurentian rocks upon the west side of the St. John River may be well seen in the sections afforded by the western extension of the European and North American railway. On the line of this route, the most northerly point at which the rocks in question appear is Law's Brook, near the boundary line between the counties of St. John and King's. They are here covered with red sandstones and conglomerates of the Lower Carboniferous formation, which intervene between them and the rocks of the

Western Extension E. and N. A. railway.

Kingston series on the north, and which may also conceal Lower Silurian strata, similar to those which are seen at several points eastward, overlying the granitic rocks. Between the brook named and Vernon's Pond, the entire space is occupied by these latter, which, in proceeding southwards, are as follows:—

Section from Law's Brook to Vernon's Pond.

	FEET
Granitic gneiss, with little mica, and having rounded fragments of hornblende slate, quartz, etc., enclosed; and	
Greenish chloritic gneiss, with much pyrites, and pebbles from one to six inches in diameter. This and the last have together a width of about	1,200
The above beds pass into a granite with red feldspar, reddest towards the southern side. Breadth	1,000
Rocks concealed for about	1,200
After these there is a dark grey gneiss or granite, lighter colored on the southern side	1,000
There are then one or two outcrops of granite with red feldspar in a space of about	2,000
Granite and granitic gneiss with red feldspar succeed, having a dip about S. 40° E. < 70°. Width	2,000
There is then a mass of grey granite, part of which has the aspect of a conglomerate. This appearance arises from the presence of round and oval blotches of darker gneiss and granite, varying from one half-inch to a foot in diameter. These blotches can sometimes be traced in lines of four or five, having a rudely east and west course. The width of this mass is about... ...	3,000
This passes into greenish-grey granite, with dykes of dark diorite, of which, along the railway, may be seen about	1,200

Vernon's Pond to South Bay mills.

Along that portion of the railway-line which is included between Vernon's Pond and the South Bay mills, the older rocks, which are of the calcareo-silicious formation of the central belt, are mostly concealed by deposits of clay. At a few points, however, outcrops may be seen, and are similar to those better shown in the Narrows of the St. John River, and the Green Head peninsula. On the north side of Vernon's Pond, the rocks in question are separated from the granite by a fault running northwest. There are here about one hundred and twenty feet of slaty silicious rocks. On the south side of the same pond, a large body of hard grey limestones comes into view, exposed in a cutting, of which the first thirty feet is the slaty silicious rock just mentioned. This cutting shews well the foldings of these beds, there being six synclinal and anticlinal folds in the space of about three hundred feet. At the next cutting limestones and slates are again exposed, the latter slickensided and much crumpled and folded. There is a third cutting in dark grey and black silicious rock, exposing an anticlinal, followed by grey and dark grey limestones, also folded.

Fault.

Folded strata.

Beyond the cutting last mentioned, there is a long flat of stratified clay, where no ledges are visible along the railroad, but to the westward of which are steep hills of fine grained silicious rocks, and to the east, alternations of limestones, calcareous conglomerates and fine grained silicious strata. On each side of South Bay Creek, there are ledges of grey and dark grey limestone, and grey fine grained silicious beds, dipping to the northward at a very high angle. Between this point and the coast at Manawagonish Beach, the rocks are entirely concealed by heavy deposits of gravel, sand and clay. South Bay.

In tracing the calcareo-silicious group above noticed to the westward, hard grey and white limestones, similar to those of Vernon's Pond, were observed at many points along the road which extends from this place into the partially cleared district about Menzies Lake. The dip is variable, but where most regular, is about S. 10° E. $<70°$. With the limestones the dark grey silicious beds are also seen, and less commonly beds of diorite. On the southern side of the belt, the limestones of South Bay may be traced westwardly to the outlet of Spruce Lake. Along the Spruce Lake stream, there are associated with these limestones buff and blue slates, trending westwardly with a southerly dip of 50°. Menzies Lake

With a view to the determination of the position and limits of the silico-calcareous and gneissic belts in this portion of the county, two traverses have been made of the wooded country lying north of the St. Andrew's road, and about Spruce Lake; the first by a wood-road, which, on the eastern side of the lake, connects its two extremities; the second by a similar road on the western side, running northeast from the St. Andrew's road at Sawyer's to Menzies Lake. The infrequency of exposures in this uncleared region prevents the observer from obtaining a clear view of the relations of its rocks, but enough is seen to indicate their general range. Traverses.

The depression of Spruce Lake, at its southwest extremity, is partly filled with coarse red sediments, dipping S. 30° E. $< 80°$, which rest upon crystalline rocks of the Laurentian system. So far as these are visible for a quarter of a mile northward on the road first mentioned above, they were found to consist of grey granite, beyond which are outcrops of fine grained dark grey diorite. At the distance of one and a half miles from the lake, ledges of pyritiferous quartzite appear; and again, one mile beyond, where a small brook crosses the road, are other quartzites and fine grained silicious beds. At the head of the lake, where a small canal connects the latter with Menzies Lake, a few exposures were seen of gneiss and diorite. Along the line of the second traverse (west of Spruce Lake), a similar succession is met with. For three-fourths of a mile from the St. Andrew's road the rock is granitoid, of a greyish or greenish-grey color, much of it containing pale red and green feldspar. This is followed by a fine grained grey gneiss, dipping northwesterly, and dark grey gneiss with diorite; and one mile out by silicious Spruce Lake.

slate and quartzite. In the low wooded area about the head of Spruce Lake, these were the only rocks seen; but near Jameson's, these meet the limestones and diorites already noticed as extending thence to Grand Bay on the St. John River.

For a mile or two west of the Seven-mile Inn, along the post-road which here skirts the southern shore of Spruce Lake, exposures of gneissic granite are not infrequent, partly concealed by overlying red sediments, similar to those at the southeast end of the same lake, and again beyond Lancaster. the latter, to the village of Lancaster. Through this region the granitoid rocks are mostly of the grey variety, often with a pale green and red feldspar. Some coarse reddish granitoid gneiss is also met with, but is less abundant than the former variety; while beyond Negro Brook, near the eastern limit of the settlement, there are with these granitoid rocks beds of fine grained dark grey Pisarinco. diorite.

Between the St. Andrew's road on the one side, and the depression extending through from Pisarinco Cove to Black Beach on the other, a triangular area terminating on Musquash Harbor and River, is for the most part composed of rocks resembling those of the Laurentian districts already described. Near Pisarinco Cove the strata are chiefly those of the Upper series, embracing limestones, diorites and quartzites, the relations of which are indicated in the following descending section taken along the shore in this vicinity.

Traverse measure.
FEET

Pisarinco section. Pale olive rust-spotted and reddish slates and soft black carbonaceous shales of the St. John group; dip S. E. < 50°. These rocks are exposed on the southern side of Mill Creek, beyond which, in the same direction, the strata are inverted rocks of Huronian age.

Crystalline limestone, with graphitic layers. 300

[These limestones, which form the northwest side of Mill Creek, underlie the above named slates, with the same dip and strike, but are separated by a strongly marked line of demarcation, and exhibit no passage beds. They are probably the equivalents of the graphitic and ferruginous beds which form the summit of the series in the parish of Portland, and are underlaid on the north by beds of similar character, as given below.]

Crystalline limestones, gray and beautifully white, alternating with quartzites and diorites, and with occasional bluish argillites. The diorites are often epidotic, and sometimes fine grained, breaking into angular fragments. They form beds from ten to twenty feet in thickness, the associated limestones varying in breadth from twenty to sixty feet, and the quartzites, which are grey and pale-weathering, from twenty to one hundred feet. The dip of these strata varies from S. 70° to S. 10° W < 80°; the aggregate breadth of the whole being about 520

[With the limestones above noted are some thinner beds of yellowish and purplish colors, which contain serpentine. Towards

the summit of the series the limestones contain small dark gray irregular beds, which are sometimes graphitic. They here dip S. < 60°. but exhibit several sharp folds.]	
Measures concealed	60
Gray quartzites alternating with diorites, the former in beds from twenty to one hundred feet in breadth, the latter from fifteen to twenty. Breadth of the whole...	450
Measure concealed	290
Gray impure and steatitic limestones, alternating with pale greenish-gray. calcareo-magnesian slates, and silicious slate, in beds from ten to twenty feet in breadth	100
Gray calcareous slate, with dykes of diorite and small veins of calc-spar. The cleavage planes in these slates are more obvious than the bedding. Two or more dykes occupy these cleavage planes, and are apt to mislead as to the stratification. They are greenish-gray in color, and somewhat columnar, having an underlie S. E. < 80°	40
Hard bluish-gray limestone, the dip here changing from E. < 60° to S. 20° E. < 60°.	200

The last named beds are followed by about 200 feet of diorites, alternating with blue and pale gray hard limestones with beds of steatite, which, with those last noted, may be the above series repeated by faulting. From this point the succession is not easily made out, alternations similar to the above occurring for some distance, and being greatly obscured by faults. One of the latter, corresponding to a cleavage plane dipping S. 70° E. < 40°., is visible for one eighth of a mile, and by it the quartzites are again brought up upon this part of the limestones. At one point in the last named rock pale apple-green and pinkish limestone is enclosed in a bed of diorite, both rocks being traversed by veins of serpentine holding chrysotile. Serpentine.

The preceding measurements are from the shore north of Mill Creek. Those which follow are from the road between the latter and Spruce Lake, and owing to imperfect exposures are only approximate.

Section south of Spruce Lake

	FEET
Diorite	50
Bluish and pinkish limestone	15
Measures mostly concealed, but disclosing several beds of diorite	3,600
Measures concealed—latter part granite	650
Alternations of fine granitic and syenitic gneiss	450
Bluish-black fine grained diorite...	250
Space with a ledge of granitic gneiss midway between the beginning and end. At the latter is a high and continuous ridge of trap-like slate..	250
Trap-like slate, similar to the above, around which the gneiss appears to fold, occupying the greater part of a space of	620

The last measurement extends to the St. Andrew's road at the foot of Spruce Lake.

Musquash Harbor, eastern side.

The strata exposed upon the shore of Musquash Harbor and River, like those of Pisarinco above described, are in part composed of granitoid rocks, and in part of the calcareo-silicious beds of the Upper Series in connection with them. The lower portion of the formation, consisting of conglomerate-gneiss, syenitic and ordinary granitic gneiss (of Divisions 1 to 3 of the section as given on page 31), and having a dip S. 20° E. < 70° in its southern part, extends down as far as Conner's Cove, below the Narrows at the head of the harbor. On the south side of this cove higher beds appear. These are hornblende schist, granitic gneiss and a pale greenish, apparently talcose gneiss, the latter dipping S. 20°. W. < 60°, the upper part being ferruginous and traversed by veins of ferruginous bitter-spar, with copper and iron pyrites. These rocks form a part of Division 3. South of this, the beds run nearly parallel to the shore along the harbor side, exposing thin beds of serpentinic marble, with non-micaceous granitic gneiss, hornblende-slate and epidotic hornblende rock, dipping S. 60° W. < 50°. Towards the head of a cove, beds of crystalline limestone are intercalated, and the measures, which begin to resume the normal strike, disappear beneath stratified clay. On the south side of this cove, beyond Hayward's brick-kiln, the quartzites of Div. 6 were found dipping southward at an angle of 15°, and traversed by a dyke of diorite having a southwest course. The quartzites extend onward to another cove, the dip increasing to S. 10° W. < 50°. Here the overlying pale olive silicious argillites of Division 7 were observed, as also a fault running N. 65° W. On the south side of this break limestones with sparry beds, probably the same as those above noted, are again brought to the surface with a southerly dip of 70°. For 550 feet across the head of the cove the measures are concealed, but beyond, between it and Frenchman's Creek, is a low headland of gneissic rock with much pale green chloritic matter, and some mica. The dip of these beds, which are a part of Division 3, and are brought to the surface by another fault, is about 30°.

The talcose or chloritic gneiss last mentioned also occupies the shore on the opposite side of the creek, and thence onward to the marble quarry. Here the limestone beds, which extend through from Frenchman's Creek along the eastern side of the gneissic ridge, come to the shore. Beyond the quarry-wharf, the limestone strata and the sparry beds immediately above the gneiss are reversed, dipping N. 20° W. < 80°, and are finally cut off by a fault running east with an underlie S. < 70°. On the south side of the fault are the main limestone beds above the gneiss. Here occurs a greenish gray dioritic rock, supporting forty feet in thickness of limestones, partly gray and partly white crystalline beds, with intermingled serpentine. This is covered by six feet of gray calcareous slate, and as many more of diorite divided by numerous joints parallel to the last fault. The dip of the limestones is S. 60° W. < 30°. Another fault follows, succeeded by slaty gray limestone and sparry beds. (Dip N. 80° E. < 40°.) At the beach the dip is reduced to N. 40°.

E. $<20°$, and beyond it these older rocks are covered by black shales of the St. John group.

A portion of the beds above mentioned as exposed on the eastern side of the harbor, reappears upon the western side, but they are here more largely covered by sediments of later origin. At the Narrows a ridge of the gneiss, with pink and pale green feldspar, crosses the harbor and runs southwestwardly towards Chance Harbor. Devonian sandstones flank it on the northwest, and conglomerates and slates similar to those at the base of the Devonian series, cover its eastern slope, and extend for more than half a mile along the harbor side. They are succeeded by the gray gneiss with pale green chlorite (?) of Division 3, seen on both sides of a large cove. Towards the mouth of the harbor this rock is covered by white and gray limestone of Division 4 (dip S. 10° W. $<40°$), followed by hard gray beds and black calcareous slate. Upon these rest the buff dolomite and dark gray limestones seen at the marble quarry on the opposite side of the harbor. This band of rocks may be traced across to Little Musquash Harbor, where it runs out into the bay. On this, as on the eastern side of Musquash Harbor, it is covered southwardly by green schistose strata of Huronian aspect. On the east branch of the Musquash River, the gneissic rocks extend northward as far as Still Water, above the Lancaster mills. They do not present any features differing from the aspect of the series as noted on the St. Andrew's road and in the direction of Menzies Lake. The rock is rather a granite than a gneiss in appearance, the stratification being usually quite obscure. Portions of it are marked with dark blotches, like the conglomerate-gneiss in other parts of this district. **Musquash Harbor, western side.**

Along the post-road which connects the village of Musquash with that of Lepreau, the granitic rocks are partly covered by more recent sediments, mostly in small outliers. From the bridge over the west branch of the Musquash River to the point where the road to Chance Harbor diverges from the highway, the rocks are Devonian (Dadoxylon) sandstones. Beyond this point, at the distance of about one and a half miles (at W. Shephard's) are heavy beds of diorite. Towards Hanson's Stream, rough knolls and hummocks of coarse granitoid gneiss containing large crystals of mica, appear. The same rock, but of a finer grain, is also seen at frequent intervals between this stream and the west branch of the Little Lepreau River, being partly covered near the latter by an outlier of reddish-purple conglomerate. Between this point and the county line are beds of contorted granitic gneiss, and granite holding pink feldspar. **Musquash to Lepreau.**

On the road which diverges southerly from the point last named to Lepreau Basin, thick deposits of clay and loam conceal for some distance the underlying rocks, but near where this road separates from that running out towards Lepreau Harbor, outcrops of granitoid gneiss with green and red

feldspar may be seen. South of the junction of the two roads granitic gneisses rise from beneath the beds of gravel and sandy loam, and dip N. 80° W. < 40°. Half a mile north of the bridge on the Little Lepreau River, these rocks become covered by ledges of Dadoxylon sandstone.

West of Lepreau.

Along the coast to the westward of Lepreau Harbor we have not met with any rocks which can with certainty be referred to the Laurentian system. Throughout the region in question the rocks are mostly highly crystalline and often granitoid, but in their paler color and more schistose character, as well as in the general dissemination of pale green chlorite or talc through the coarser beds, they approximate more nearly to those of the Coast group of Huronian strata, in connection with which they will be more particularly described. With these Huronian rocks, however, others are sometimes met with which cannot readily be distinguished from those of the more ancient Laurentian system. They may be seen in several of the headlands between Mace's Bay and L'Etang Harbor. The calcareous and silicious rocks of the last named haven, and of Frye's or Cailiff Island, which have been referred to as apparently representing the Upper series of the Laurentian area in Saint John county, will also be more fully described in connection with the Huronian rocks associated with them.

Supposed interior Laurentian ridge.

It has been stated in the general remarks that gneissic rocks bearing much resemblance to those of St John County, may be distinguished at several points within the belt of crystalline rocks which traverses the central portion of Charlotte, and parts of King's and Queen's Counties, and appear to indicate the existence of a second or central ridge of Laurentian sediments parallel to those of the coast. Over much of the area occupied by this belt, these ancient rocks are concealed by sediments of more recent origin; a portion of these are of Silurian and Devonian age, and others are Huronian. They lie around the northeastern and southwestern points of a great mass of granite, which is supposed to be intrusive, and is distinguished from the older granitic rocks by differences both of color and composition.

St. Stephen.

Of the gneissic rocks supposed to belong to the Laurentian system in western Charlotte, the most typical and interesting are those to be seen about the St. Croix River, in the neighborhood of Calais, St. Stephen and Baring, where granitic and syenitic gneisses appear at frequent intervals, varying somewhat in color and composition. In Calais and St. Stephen much of the rock is a rather coarse dark grey syenite, often rusty and pyritous, but sometimes containing minute grains of magnetic iron or ilmenite and yellow mica; while other portions are of lighter color and finer grain, sometimes holding masses or pebbles of the darker rock, and presenting the aspect of an altered conglomerate. At the lower falls on the Calais side, gneiss of this character appears, apparently dipping S. 20° E. < 50°, and continues up the stream for half a mile. At the lower fall in Milltown these

Milltown.

beds, previously dipping S. 60° W. $<80°$, meet a grey gneiss and quartzite dipping N. 70° E. $<90°$. Still further up the stream, near the railway bridge at Salmon Falls, considerable quantities of light grey granite are associated with the gneiss. These are probably intrusive, as veins of the former penetrate the latter, cutting across the beds, while in the body of the granite are contained numerous fragments of grey fine-grained gneiss, quartzite, etc., still retaining their original lamination. Some of the boulders in Milltown, derived from these rocks, exhibit enclosed fragments of gneiss not less than from four to six feet in length.

Northward of Milltown, rocks similar to the above may be observed on the Cemetery and Chandler roads, consisting usually of syenitic gneiss, more or less coarse, holding light colored granitic veins, and beds or veins of fine grained granite. Here too the rock contains imbedded fragments, but the resemblance to a conglomerate, noticed above, is not so conspicuous as in that displayed a few miles to the west, at the falls in Baring. The rock here consists of a light grey granitic base in which are contained numerous dark, rounded and irregular fine grained masses, the general arrangement of the latter seeming to correspond to the dip of the more evidently gneissoid portions (S. 10° W $<70°$), but both are variable. This type of rock may be seen on the New Brunswick side of the river, along the Lewey's Island railroad, for a distance of a little more than two miles, until (at the water-station) it is met and overlaid by a fine grained grey schistose gneiss with mica-schists, of uncertain age. The contact of these two rocks with the granite is peculiar. The schistose gneiss last named, having a regular southerly inclination of 60°, dips towards and upon the granitoid mass, by which it appears to have been abruptly cut off, while, enclosed in the latter for several feet from the line of contact, are long irregular blocks of the schistose rock, as if these had been detached and sunken in the granitic mass, while this was in a softened and yielding state. These enclosed fragments are easily separable from the surrounding rock, and are quite unlike the dark firmly imbedded masses which elsewhere characterize the granitic gneiss of this region. Their occurrence would seem to suggest either a softening of the older series through metamorphism at some period subsequent to the deposition of the upper strata, or else that these light colored granites are intrusive. Dr. Hunt, who has visited the locality, and who has observed rocks of a very similar character breaking in repeated instances through schistose silicious rocks at Biddeford and Saco Pool in the state of Maine, is inclined to entertain the latter opinion.

Baring.

Lewey's Isd. R.R.

Contact of formations.

Appearances suggestive of the same view may be seen at the village termed the Ledge, about three miles below St. Stephen. The shore of the river is here composed of a dark syenitic gneiss, portions of which present the appearance of having been violently broken into numerous angular fragments, and the whole cemented by veins of a light colored porphyritic granitoid

The Ledge.

felsite, a rock containing much feldspar, with but little mica or quartz. With these rocks, which appear along the shore for the distance of a mile, and which nearly resemble those of St. Stephen and Baring, are also found porphyritic diorite and light colored granites in dykes or beds. Similar white or tawny white-weathering granites, associated with diorites and syenite, form much

St. Croix river.

of the peninsula which, below the Ledge, separates the channel of the St. Croix River from that of Oak Bay, and which terminates in Oak Point. They may also be seen, and have been quarried, on the western side of the river in Calais, where they meet the great mass of red granitoid felsites which form the right bank of the river through Robbinston. Between the Ledge and the town of St. Stephen the older rocks are for the most part concealed by ferruginous gneiss, argillo-carbonaceous schists, and micaceous quartzites.

District east of St. Croix river.

We cannot attempt to define with precision the distribution of these two sets of rocks in the district adjacent to the last named town. Throughout this region fine grained gneissic, schistose and micaceous strata similar to those above alluded to, are found resting upon, and more or less completely concealing the more ancient system, and are themselves at some points associated or interstratified with grey granitoid hornblendic gneiss, which is partly micaceous, and passes into granite. These overlying sediments resemble the rocks of the Upper series in the Laurentian area of St. John County, except that here no limestones have yet been observed. Where the older rock is exposed, as on most of the roads leading out from St. Stephen to the north and east, it is very generally a coarse grained and dark, often rusty, syenitic gneiss, in some parts destitute of stratification, but in others distinctly stratified, the beds being usually greatly contorted. With this ordinary type, however, there occur at two points to the northeast of St. Stephen rocks of very different aspect

Diorites with serpentine.

These are the dark grey dioritic rocks containing serpentine, diallage and chromic oxyd, to which reference has been made in the general remarks. The first of these points is on the Basswood Ridge road, about two miles north of St. Stephen, where may be seen ledges of coarse grained dark grey granitoid diorite, having thin layers of picrolite or serpentine in the joints, as well as serpentinous matter in the body of the rock. Loose pieces derived from

Diallage.

veins in the mass contain moderately large cleavable crystals of diallage. In crossing these ledges towards St. Stephen the rock becomes somewhat darker, and portions are met with exhibiting thin lamination, the laminæ being separated by layers of serpentine about one-eighth of an inch in thickness, and dipping N. 75° E. < 50°. Portions of the rock are porphyritic with large crystals of feldspar. They are followed to the south, at the distance of a few yards only, by micaceous quartzites dipping N. 10° W. < 70°, thus indicating un-

Contact of formations.

conformability between the two sets of strata.

At the second point where these rocks appear, also about two miles from

Little Ridge Road.

St. Stephen, on the road running through Little Ridge Settlement towards Moore's Mills, the stratified character of these serpentinous diorites is still more

marked. The latter are here of a very dark, almost black color, consisting of black hornblende, a little feldspar and some mica, and occasionally diallage, the serpentine bands being numerous, but thin and parallel to the bedding. The latter is very regular, dipping N. 40° W. < 70°. Ledges of this rock are exposed along the road for a quarter of a mile, much of it with a concretionary aspect, and weathering with a rough surface covered with rounded prominences and depressions. Its dip in this distance changes to N. 60° W. < 70°. It is followed, after an interval of about a quarter of a mile covered by boulder-clay, by grey micaceous quartzite and rusty-weathering quartzose gneiss, dipping S. 10° E. < 40°.

On the Dennis Stream, which flows a little to the eastward of and parallel to the road last alluded to, the dark diorites with serpentine have not been met with. Syenitic gneiss, like that of St. Stephen, appears, however, at several points, as in a ridge near its mouth crossed by the post-road from St. Andrew's; again about one mile northward between the stream and the road to Moore's Mills, and yet again about a mile northward of Moore's Mills, on the road to Tower Hill. Still farther northeast, on the west side of Foster's Lake, are bluffs known as Porcupine Knoll, consisting of a coarsely crystalline diorite, in which dark green prismatic hornblende predominates, while a similar rock appears between the same lake and the old highway to Fredericton, about one hundred rods from Bailey's Crossing, and again about two miles west of Moore's Mills. At all these points the dioritic and syenitic rocks are surrounded by the quartzose mica-schists and argillo-micaceous schists, to which reference has been before made. Dennis Stream. Foster's Lake. Bailey's Crossing.

Over much of the country lying to the east of the Dennis Stream, and within the parish of St. David, thick beds of boulder-clay obscure the older formations, but at one or two points the latter may be seen, as on the east side of Gallup Lake, where they consist of greyish-white granite much like that of Oak Point, and hold coarser granitoid veins with much white kaolinized feldspar; and again nearly due east of this lake on the Woodstock road near the parish line. At this point they present small areas of dark syenitic gneiss, surrounded as before by schistose strata similar to those of Bailey's Crossing. St. David's.

In approaching from the west the parish of St Patrick, the dark grey gneisses become again visible near the Roix station on the St. Andrew's and Quebec railway, here presenting features similar to those seen in the rocks of the Ledge and Milltown. They thence extend along the post-road as far as Dyer's inn on the Magaguadavic River, marking the northern limit of a great body of these rocks occupying much of the country between Oak Bay and the last named river. So far as observed in the hilly and wooded country between the latter and Passamaquoddy Bay, the rock is more homogeneous than that near Roix's, consisting for the most part of a dark grey, more or less coarse syenite, without evident stratification, and less St. Patric

frequently of granite. The last named rock may be seen in the lower portion of the peninsula which separates Oak Bay from Waweig Bay, and again on the eastern side of the latter, where, with grey syenite, it forms the shore of the St. Croix from Waweig bridge to a point nearly opposite the Devil's Head in Calais. It is here met by a red syenitic felsite similar to that of Robbinston in Maine.

Chamcook Lakes.

Between the shore above described and the railway, the dark syenitic rocks rise into hills of considerable altitude, and are well exposed upon the latter between the Upper Chamcook Lake and Goldsmith's Lake. They here consist, for the most part, of grey and dark grey syenite, sometimes micaceous, with light colored granite in dykes and veins. With these are also sometimes seen small masses of pink or reddish granulite, from which veins also pass into the darker rock. To the southward they are followed by red syenites similar to those of the St. Croix River.

Frye and Glenelg roads.

In the hilly region lying to the eastward of the railway, reddish granitoid rocks of the type last alluded to are more abundant, being met with along the Frye and Glenelg roads, as well as in the intervening space near the foot of Bonaparte Lake. They are here in patches of limited extent, but upon the road last named, between Bonaparte Lake and the Upper Bocabec Lake, they cover more considerable areas. Excepting these red rocks, which may be partly intrusive, the Glenelg road, from within half a mile of the St. Andrew's road to Dyer's inn, a distance of about eight miles, passes over crystalline rocks resembling those of the Laurentian system, being for the most part dark colored dioritic and syenitic rocks, but associated on the north side of Bonaparte Lake with considerable masses of pale grey granite.

Bocabec.

To the south and east of the Glenelg road similar crystalline rocks have been observed near the lower part of the upper Bocabec Lake, and along the Bocabec River nearly to the head of tide-water. Except that at one point, midway between the lake and the mouthof the river, there is a dark micaceous gneiss, with feldspar, black mica and a little quartz, the rocks in this area, which project in numerous bare ridges and knolls, do not differ from the dark syenitic rock elsewhere so common in the region under consideration. Similar rocks were observed to the east of Bocabec River for a distance of about two miles, where they pass beneath dioritic and silicious strata of more recent age, the latter filling the remaining space to the Digdequash River.

The southern border of the granitic tract to which the above descriptions apply is extremely irregular, the more ancient rocks being here overlapped by newer deposits, mostly of the Mascarene series, which, in nearly horizontal beds, border the northern shore of Passamaquoddy Bay, and extend up in several bays or valleys between the ridges of the underlying gneiss. The latter, at several points, extends southward to the post-road, within a mile of the bay-shore. One of these ridges, overlooking

Bocabec Bay, and just south of the Glenelg road, is very coarsely crystalline, and has associated with it small beds of pinkish granulite and reddish syenitic felsite. Bocabec Bay.

In that part of the belt of crystalline rocks which intervenes between the Digdequash and Nerepis Rivers, no gneissic rocks resembling those of the Laurentian series have been met with. Much of this tract, however, remains unexplored.

Of the district to the east of the Nerepis River but a partial examination has been made. In making traverses, however, of the hilly country intervening between the upper part of this stream and the St. John River, rocks resembling those of the Laurentian system have been met with at several points in the Nerepis valley, and along the northern flank of the range of intrusive granites which culminates in Bald Mountain. Nerepis valley. The most westerly point at which the rocks in question have been observed is along the northern face of the bold hills south of the valley last named, a little above Welsford station. They here consist of a grey syenite, composed of a glassy grey feldspar, black hornblende, quartz, and a little mica, rather loosely aggregated, and crumbling readily to a coarse gravel. Grey syenite. This rock exhibits traces of lamination, the laminæ dipping N. 10° W. $<$ 40°. At the foot of the higher hills composed of this rock, are ledges of a coarse dark green or black diorite, of concretionary aspect, containing a nearly black hornblende and white-weathering feldspar; while scattered in the soil, and evidently indicating a ridge *in situ*, are numerous loose fragments of pale red granular felsite. Felsite. A plateau, more than a mile wide, and composed chiefly of quartzites and diorites, supposed to be of Upper Silurian age, separates these rocks from the valley of the Nerepis stream, on either side of which hard bluish-grey slates of this age appear. From beneath these latter, however, on the north side of the valley, and overlooking the Fredericton road, one or more high ridges composed of a coarsely crystalline diorite or syenite, and containing disseminated grains of magnetic iron, rise into view, and probably pertain to the more ancient system. Diorite and magnetic iron.

Similar syenitic and dioritic rocks containing magnetic iron have also been met with several miles to the eastward, both to the north and south of Hardscrabble Settlement, where they have in like manner been exposed by denudation of overlying Upper Silurian sediments. Hardscrabble. At the outlet of the easternmost Bald Mountain Lake, these rocks are associated with masses of a dark grey micaceous quartzite, possessing a greenish tinge. The rocks of this area resemble Divisions 3 and 6 of the St. John section (page 31). In the district immediately to the eastward of Hardscrabble Settlement, the older rocks are mostly concealed from view by dark colored petrosilicious Huronian beds and Upper Silurian slates; but among the high hills composed of these rocks, which appear still further east in the parishes of Hampstead and Greenwich, rocks resembling those of the Laurentian Hampstead and Greenwich

system again become visible. In the broken district northeast of Oak Point, on the St. John River, and along the road connecting the latter with Jerusalem Settlement, as well as about Long Lake, these rocks are coarsely crystalline diorites and syenites of a grey color, often containing magnetic iron, and are probably a continuation of those above described in the Nerepis valley; but about Fannen's Lake (one mile east of Long Lake), and thence extending to the St. John River along the boundary line between King's and Queen's Counties, grey fine grained granites come into view. These are the granites described in the general remarks at the beginning of the section as resembling those of St. Stephen and Baring. It is possible that they are of intrusive origin, but their relations to the associated rocks on either side are not sufficiently known to determine this point. On the southern side, the beds observed to be nearest to the granite belt consist of dark grey, very fine grained gneisses and micaceous quartzites, the latter holding epidote. They dip northerly or towards the granite at an angle of 70°. In passing to the northern side of the crystalline belt, the grey granites, which form its principal mass, are found to give place to a granite of similar character, but of a paler color, and containing two feldspars, the one being white, and the other pale red. Near the granite quarries the contrast between these rocks is not very marked, but in crossing the ridges in the rear, and in the vicinity of Fannen's Lake, they are found to contain a predominance of red feldspar, and in other respects to resemble the intrusive granite of the Nerepis hills, These rocks, which, along their northern edge send veins into the overlying schistose beds, will be made the subject of further remark in another connection.

Fannen's Lake.

Grey granites.

Red granites.

On the eastern side of the St. John River, opposite the Hampstead quarries, the older crystalline rocks are no longer met with, the only strata visible here being schistose and dioritic rocks of Huronian and Silurian ages, which form the shore for several miles, and occupy the greater portion of the parish of Kars. The crystalline rocks described in the general remarks as extending through the parish of Springfield, are very similar to those met with in the Nerepis valley, and along the northern flank of the Bald Mountain range. Near the western limit of the belt in the Scotch Settlement, where the rock is mostly a coarse grained diorite, small quantities of antimony ore have been obtained. Further east, near Sunnyside Lake, the rock contains a considerable admixture of magnetic iron, and veins composed of this mineral, with feldspar and hornblende, were met with, some of which were as much as six inches in width. Further east, there are with these dioritic beds coarsely granitoid rocks of greenish-grey and reddish colors, some of which are intrusive.

Kars and Springfield.

Antimony and magnetic iron.

In describing the rocks which we suppose to be of Laurentian age in the district immediately surrounding the town of St. Stephen in Charlotte County, reference has been made to the fact that these are often associated

St. Stephen.

with and overlaid by a series of highly crystalline rocks, embracing mica-schists, quartzites, and imperfect gneisses, the latter at some points passing into granite. In some respects, the rocks in question differ from any that we have elsewhere met with in the Province, while their relations to the associated strata of the same district have not as yet sufficed to fix their age with certainty. Their position, however, with reference to the underlying granites and syenites, and the fact of their being at some points overlaid by a considerable mass of dark grey and black shales, which resemble those of the St. John group, taken in connection with their extreme metamorphism, would appear to indicate that they are intermediate between the Laurentian and Primordial series, aud may be the equivalents in part of the Upper series described in the preceding chapter as occurring in connection with the first named system near the city of St. John. They show a further resemblance to this series in the highly carbonaceous and pyritous character of many of the strata, and in the abundance of quartzites. We propose to describe in this connection, the entire assemblage of these strata met with in the region under consideration.

Mica-schists, &c.

The beds which are apparently the oldest among the strata in question consist of dark rusty-weathering carbonaceous gneiss and dark grey clay slates, which, at many points, may be seen surrounding and resting upon ridges or knolls of dark grey syenitic gneiss of the older series. Such strata may be seen at several points along the line of the St. Stephen branch railway and in the valley of Dennis Stream, and again to the eastward of the latter, over the triangular area included between the St. Croix River and the depression of Oak Bay. They are also met with at many points north of St. Stephen, and in the town of Calais. They are, in general, soft and pyritous as well as carbonaceous, and are usually highly contorted, their irregularities of dip being apparently connected with the inequalities of the underlying gneiss. Near Oak Bay these ferruginous gneisses are the only rocks met with, being covered by a series of dark grey and black pyritous shales, resembling those of the St. John group, which intervene between them and a mass of grey conglomerate, probably of Upper Silurian age; but further west, on the shore of the St. Croix River, above the Ledge village, the gneisses in question are separated from the same conglomerates by a mass of grey micaceous, often pyritous, and rusty-weathering quartzites, which dip towards the conglomerate, and apparently beneath it. These quartzites are associated with grey slates, and are probably the same as those met with elsewhere in this district occupying a similar position. Their dip along this shore is mostly southerly (S. 20°—40° E. $<$50°—60°), but with many irregularities, the beds exhibiting a tendency to fold over on an axis directed downwards to the north east. Towards and at the mouth of Dennis Steam, the dark grey rusty gneisses, which here form the shore, have a dip S. 80° W. $<$ 70°—50°.

Rusty and carbonaceous gneiss.

Oak Bay.

St. Croix River.

Dennis Stream.

The valley through which the last named stream flows to its junction with the St. Croix River, near St. Stephen, is mostly occupied by beds similar to those above described, embracing fine grained imperfect gneisses and grey micaceous quartzites (with some argillites), but towards the head of the same creek, and about Moore's Lake, there are with these latter considerable masses of well defined mica-schists, containing crystals of staurolite, andalusite, and garnet, the first named mineral being very abundant in some of the beds. We have not elsewhere met with strata presenting these features, but they appear to form a portion of the same series with the imperfect gneisses already noticed, being associated with beds of similar character, and in like manner overlaid by thick deposits of grey micaceous quartzites. They appear to be somewhat local in distribution, being confined to the vicinity of Moore's Lake, along the eastern and southern sides of which they are well exposed, with a southeasterly dip of about 40°. Towards the head of the lake, and in the village of Moore's Mills the rocks are micaceous schist and grey gneiss, which alternate with thin beds of dark greenish-grey hornblendic or actinolite-rock, and black rusty-weathering carbonaceous shales. The beds here are much faulted, and contain veins, some of which are quartzose, containing pyrites and finely radiated black tourmaline, while others are composed of quartz with orthoclase feldspar and mica, the latter in moderately large crystals. North of Moore's Mills are grey slates, and rusty-weathering quartzites, succeeded in the same direction by bands of grey and dark grey argillites.

Staurotide garnet, &c.

Moore's Mills.

Through the district to the west of Moore's Mills, and north of St. Stephen, the rocks under consideration are for the most part similar to those already described about Dennis Stream and the St. Croix River, being fine grained rusty gneisses and micaceous quartzites, usually greatly contorted, which rest upon and mantle around small ridges or islets of coarse grained syenite. Their unconformability to the latter has been indicated on a preceding page. With the above named strata, however, there may be seen at some points interstratified beds of grey granitoid hornblendic gneiss, which is partly micaceous, and passes into granite. Such is the case on the road from St. Stephen to Scotch Ridge, at a point about four and a half miles from Calais bridge, and perhaps to the westward of this road on Moannoe's Stream, where grey granites are also met with. At the point first named on the Scotch Ridge road, these granitoid gneisses dip S. 10° E. < 70°. They have in some parts a dark grey plumbaginous aspect, and are regarded by Dr. Hunt as of the same type as the gneiss and mica-schists composing the White Mountains of New Hampshire. Their position in the series is probably nearly the same as that of the mica-schists of Moore's Mills.

Granitoid gneiss.

From Moannoe's Stream, the micaceous quartzites of this formation extend with much regularity to the St. Croix River, opposite the township of Baileyville, where they are well exposed along the line of the Lewey's Island

Lewey's Island railroad.

Railroad, having a southerly dip (S. 30° E. < 60°), and a breadth of nearly half a mile. An interesting contact of these gneissic and micaceous beds with the underlying granite along their southern margin has been made the subject of remark on page 49.

Dumbarton and St. David's.

In the district to the eastward of those above described, including portions of the parishes of Dumbarton and St. David's, much of the country is still unsettled, and but partially cleared. It is, therefore, difficult to obtain a satisfactory view of its geological structure. A belt of quartzites and mica-schists, however, which are probably continuous with those of Moore's Mills, may be seen skirting the northern edge of the granitoid hills of the parish of St. Patrick, and extends eastwardly towards the Magaguadavic River. They are finely exposed along the St. Andrew's and Quebec Railway, two miles north of Roix station, where they have a southward dip, at a moderate angle (30°.) Hard dark grey feldspathic shales and felsite lie along their northern border, and are followed, two miles from Roix station, by purplish-black argillites. Still farther north, at the twentieth mile-post, there is a low anticlinal of black carbonaceous shales, covered by dark grey argillites. In the Magaguadavic district, this series appears to be represented by several hills composed of fine grained grey rusty-weathering mica-schists and contorted micaceous quartzites, met with near the confluence of this stream with its tributary, the Piskahegan, and to the eastward of this point in the Piskahegan Settlement. They are seamed in all directions with veins of quartz, and bear a close resemblance to the ferruginous quartzites met with near the Suspension Bridge and in the parish of Portland, in St. John County.

St. Andrew and Quebec Railway.

Magaguadavic

THE HURONIAN SERIES.

Huronian series.

There exists in New Brunswick a great series of crystalline strata, which appear to be intermediate in geological position between the Laurentian and the Primordial fossiliferous beds of St. John. They thus occupy the horizon of the Huronian series of Ontario and Newfoundland, which they also resemble lithologically. These rocks are spread over a wide area, and probably include a great thickness of strata, with considerable variations in lithological charac-

ter in their various parts, which have led us to describe them as three different formations, a distinction which perhaps may still be maintained, though they will probably constitute divisions of the Huronian series, which in Ontario, according to Mr. Murray, attains a thickness of not less than 18,000 feet of the three formations into which these rocks have been divided, the first is called the Coldbrook group, the second the Coastal group, and the third the Kingston group.

Sub-division.

THE COLDBROOK GROUP.

History.

The name of the Coldbrook group was first given by Mr. Matthew to the series of rocks thus designated from their occurence on the Coldbrook Stream, in the vicinity of the city of St. John. Subsequently, in the year 1865, the same series of rocks was described by the authors of the present report, as seen in its extension to the eastward of that city, in their "Observations on the Geology of Southern New Brunswick." In this direction they were traced in several ridges through the eastern portion of St. John County, extending for a short distance into the adjoining counties of Kings and Albert. At several points they were observed to rest upon gneissic and granitic rocks referred to the Laurentian system, and to be in turn overlaid by the slates of the St. John group, containing Primordial fossils. From their stratigraphical position and a general resemblance borne by them to the Huronian rocks of Canada, the authors were led, in the year above named, to suggest their probable equivalency with the latter. These rocks, chiefly as they appear eastward of St. John, are arranged in the following ascending order ;—

Lower Coldbrook.

1. Dark grey and greenish-grey, usually fine grained and never very coarse diorite, with no marks of stratification in the lower part, but with obscure evidences of bedding in the upper. In the higher portion of this group is a porphyritic diorite, with large pale green crystals of feldspar enclosed in a greenish-grey paste. A bright red sub-crystalline felsite is exposed at the base of this group in a number of places, but it is not known to form a part of the series and may be intrusive. This rock, by the addition of a dark colored imperfectly crystalized mineral resembling hornblende and a little quartz, sometimes assumes the appearance of an imperfect red syenite.
2. Pale pink or white felsites and feldspathic quartzites, mostly in thick compact beds, but sometimes schistose. At the junction of these with the overlying strata there are grey rusty-weathering feldspathic sandstones which may belong to the later series. In connection with the previous division, there are masses of red and purple porphyritic felsites (feldspar-porphyry) along the more northerly of the two great bands of Huronian rocks in southern New Brunswick, but their precise relations to these Coldbrook strata have not been ascertained.

The strata above enumerated are in most places greatly obscured by overlying sediments, and have nowhere been met with sufficiently well exposed

to admit of careful measurement. There can be little doubt, however, that they are half a mile in thickness.

3. Fine grained dark grey diorites.

4a. Very fine grained grey, dark grey or black petrosilex, having in the upper part beds of diorite, chloritic schist, grey feldspathic sandstone and slate.

4b. Greenish-grey and purplish feldspathic and dioritic sandstone, seamed with chlorite and epidote, and having beds of conglomerate in which the fragments are scarcely distinguishable from the paste.

5. Greenish-grey clay slates and micaceous slates with beds of slaty dolomite.

6. Grey feldspathic sandstone, with beds of dark green chloritic schist, grey chert and breccia-conglomerate the latter having a greenish slaty paste holding fragments of felsite, quartz, etc.

* A closer examination of the conglomerate (6) has shown that it is made up of fragments of the inferior beds, with others derived from a more distant source. It is therefore to be connected with the Upper Coldbrook, of which it is the first member, and the discovery of its relations to the subjacent beds, as well as other facts, indicate that the whole Upper Coldbrook is but an unfossiferous portion of the St. John group.

UPPER COLDBROOK. (BASE OF THE ST. JOHN GROUP). Upper Coldbroo.

a. Red sandstone and conglomerate, with pebbles of quartz, felsite, micaceous quartzite, &c.

b. Red and greenish-grey argillites, spangled with grey mica. Thickness, 170 feet.

These rocks are much softer than any of the inferior Huronian beds (except those of No. 5) and, when present, are always conformable to the dark colored slates of the St. John group; but they have only been seen at the base of that group where it rests upon Huronian strata.

The thickness of that part of the Coldbrook rocks exposed in the city of St. John, is about 300 feet, but elsewhere it is vastly greater, as, for instance, on the south-east side of the Nerepis Hills in Queen's County, and in the Quaco Hills in St. John County. In both these districts Nos. 3 and 4 have a much greater bulk than near St. John. Thickness.

The several members of the Huronian series above enumerated correspond to Nos. 2, 3 and 4 of the lower division of the Coldbrook group as originally described, and are for the most part composed of hard rocks, which have resisted atmospheric and denuding agencies, and stand out boldly above the general level of the districts in which they occur; while the Upper Coldbrook strata are much softer, and as they usually occur in depressions of the surface, are largely obscured by drift. The soils of districts, in which rocks of this series occur, are of medium quality, sustaining, more especially where feldspathic beds prevail, a generous forest growth. Topographical features. Soils.

The Huronian rocks of the Coldbrook group have as yet been recognized only in the vicinity of the two bands of Laurentian and other crystalline rocks which cross the southern portion of the Province. Those which occur in connection with the more southern of these two bands, appear in two or more anticlinal ridges, extending with a north easterly course Anticlinals.

through the greater part of the county of St. John into the eastern portion of the County of King's, a distance of between forty and fifty miles.

Prior to the work of the present survey, the river St. John, at the Suspension bridge, was considered as marking the extreme western limit of the Huronian rocks of St. John County, the only sediments noticed to the westward of this point, which bore much resemblance to them, being supposed, on stratigraphical grounds, to be more recent; while in the same direction the belt of undoubted Huronian rocks was found to suffer a marked diminution in bulk, and at the river above named to disappear entirely. Recent observations, however, have led us to the conclusion that a part of these supposed more recent sediments are in reality the Huronian strata brought up by a fold, and by an overturn of the whole series made to rest upon newer strata. These overturned beds, formerly known as the Bloomsbury group, and referred to the Devonian system, extend along the coast from St. John Harbor to and beyond Musquash Harbor, and in an easterly direction nearly to Loch Lomond. The diorites and schists of Bloomsbury Mountain, although apparently resting upon the slates of the St. John group, and overlaid by Devonian sandstones, which conform to them in dip and strike, are now also regarded as Huronian strata. The facts bearing upon this question are briefly alluded to in the following remarks, but will be more fully detailed in the consideration of the rocks of the St. John group, from which the evidences of their antiquity have principally been derived.

Bloomsbury group.

Details of the Coldbrook group in St. John and King's Counties.

Musquash Harbor.

On both sides of Musquash Harbor a series of hard green epidotic subcrystalline schists, sometimes with dark green serpentine, may be seen resting upon black carbonaceous crumbling shales, full of pyrites, and having arenaceous layers towards the top. These latter dark colored rocks resemble very closely some portions of the St. John group as seen in the city of St. John, and are supposed to be continuous with them through a belt of similar rocks, extending across the peninsula of Pisarinco, and coming out at Mill Creek in Pisarinco Harbor. In this view, it is probable that the structure indicated in this group at St. John, and to be presently noticed, will hold good here also, viz.: That the St. John group is inverted upon itself, and that the green crystalline schists, though overlying that group, are in reality more ancient and probably of Huronian age.

Inversion of St. John group.

These Huronian strata, as seen in the headlands on either side of the entrance of Musquash and Pisarinco Harbors, consist chiefly of the hard greenish schists first mentioned, but with these are softer greenish-grey, purplish-red, and purplish-black argillites. The hard schists have pearl-spar in layers and veins, and dip S, 40° E. $< 40°$. They are continuous across the peninsula of Pisarinco, and at Pisarinco Harbor are several times repeated by faulting. At Mill Creek, in the Harbor last named, black slates, similar

Pisarinco.

to those of Musquash Harbor, are overlaid by green and purplish feldspathic conglomerates, dark greenish-grey argillites, veined by calc-spar and dipping S. 20° E. < 50°, dark green epidotic slates, and purplish-red argillites, dipping S. 20° E. < 40°. Further south, beyond Pisarinco Cove, the same beds are repeated.

Beds similar to those above described re-appear in Taylor's Island and Sheldon Point, promontories which intervene between Manawagonish marsh and the Bay of Fundy.

In the town of Carleton, on the western side of St. John Harbor, the strata consist to a great extent of greenish grey dioritic rock, which is more or less amygdaloidal, and encloses a few beds of petrosilex and occasional masses of dark grey diorite. A ridge of these rocks may be traced for several miles, from Sand Cove to the southern part of Carleton. Beneath these diorites, overturned beds of red and green sandy argillites and sandstones appear in Carleton, between the latter and the St. John rocks, but the contact of the two is here obscured by a narrow depression filled with clay, while farther east and near the harbor of St. John, the diorites and other greenish beds alone come into view, the St. John group being concealed beneath a tidal flat. These dioritic and associated rocks have here a very considerable width, while the belt of St. John slates becomes very narrow. In the direction of Partridge Island these latter are overlaid by the Dadoxylon sandstone containing numerous fossil plants of Devonian age. Carleton.

Within the city of St. John, this belt of strata is narrow and mostly covered by post-tertiary Leda clay and other superficial deposits. The exposures are along the western shore of Courtney Bay, where, in a space of about one thousand feet, between Sheffield and Brittain Streets, are exposed beds of hard feldspathic and dioritic schistose rocks, again resting upon overturned beds of green and red argillite, red sandstone and red conglomerate. Eastward of the city, this belt of diorites may be seen at several points protruding above the gravel and clay beds which extend thence to Loch Lomond. The first exposure is at Race Horse Point, south of the Alms House (described in the sequel in connection with the St. John group). Another outcrop forms a low ridge of dioritic and feldspathic rocks, extending along the north side of the Lower Loch Lomond road, to within a few miles of the lake above mentioned. Here it is concealed again by superficial deposits in the valley of the Mispec River, beyond which it is connected, through limited exposures, with the great body of Huronian strata in the Quaco Hills. City of St. John. Courtney Bay.

The Huronian rocks seen at the Suspension bridge are connected with the more northerly of the two anticlinal ridges to which reference has been made at the beginning of this section. Not more than fifty feet of Huronian strata appear at the bridge; from this point the belt of these rocks may be traced eastwardly through the parish of Portland, where it forms a portion of the hills in the rear of the city of St. John, and along the north side of the Suspension bridge. Portland.

valley of the Marsh Creek. It is here represented by the Huronian (Nos. 4 to 6) and by the Upper Coldbrook, both of which, near Lily Lake and eastward of it, may be seen intervening, with a southerly dip, between the gneissic and calcareous rocks described in the last section and the Primordial shales of the St. John group.

Anticlinals. We come now to speak of the two principal anticlinal ridges of Huronian rocks referred to above. The more northerly of these extends from the Coldbrook Iron Works, three miles north-east of St. John, through the settlements of Golden Grove and Damascus. It is probably this ridge which, continuing onward through Barnesville, terminates in bluffs on the Hammond River, just opposite the village of Upham. The southern ridge is much more extensive, and consists of several anticlinals of crushed strata, in which the prevailing dips at the western end are south easterly. This rises from beneath Devonian sandstones in the Mispec barrens, and extends eastward through the Quaco Hills to the Londonderry Settlement in the south eastern part of King's County, beyond which it has not been explored.

Succession at Coldbrook. Near the Coldbrook Iron Works the rocks of the more northerly anticlinal ridge present the following succession :—Hard greenish-grey petrosilicious rock, with very obscure stratification ; conglomerate with bright red slaty paste ; grey conglomerate ; coarse reddish grit and conglomerate, with purple sandstone : apparent thickness of the whole, 5,000 feet.

From the Coldbrook valley, through which the above strata (which are chiefly of Nos. 3 and 4) pass northward to the valley of Hammond River, the belt of these rocks continues to widen, and may be traced eastwardly to Loch Lomond, the bluffs along the northern side of which are composed of the Lower Coldbrook diorites, etc., while the red conglomerates and sandstones at the base of the Saint John group appear at their southwest extremity, and pass through the depression now occupied by the lakes. As their succession is here more complete, and their relations are better seen than elsewhere, the Huronian rocks of this neighborhood may be taken as representing the series throughout this district. Near the southern part of Golden Grove. the Golden Grove Settlement, the northern side of the ridge is marked by the occurrence of heavy (overturned ?) beds of coarse quartzose conglomerates (composed of numerous quartz grains and pebbles, with light red feldspar, in a grey petrosilicious base), and dark grey sandstones, dipping about 70° to the south east. Farther south, between these beds and Loch Lomond, are dark grey porphyritic and amygdaloidal fine grained diorites and purplish porphyritic petrosilex, associated with bands of ferruginous and white somewhat vesicular sandstones, (No. 2). In an easterly direction rocks similar to the above extend along the north side of the Loch Lomond lakes to and beyond Barnesville. Barnesville. In this settlement there is a long ridge of the sediments of this age, which terminates opposite the village of Upham, on the Hammond River, in King's County, in a bluff of red feldspar rock. The structure of this ridge

in Barnesville appears to be synclinal. Towards the centre of it, at the grist-mill on South Branch, the ferruginous sandstones (Div. 2, page 58) may be seen. On either side of the sandstone band, in the more elevated part of the ridge, are enclosing masses of dioritic and petrosilicious strata ; and on both sides of its eastern termination are cliffs of red rocks, mostly made up of red orthoclase feldspar, with grains of quartz. In some of the beds these quartz grains are large and distinctly rounded. There are associated with these coarser feldspathic beds, others of finer grain and apparently more silicious. These are variegated with green and red colors, and filled with radiated concretionary masses.

At the south west extremity of the first Loch Lomond lake, the dioritic and conglomerate beds in the upper part of the Huronian series are followed by very hard fine grained sandstones of a bright red color, portions of which contain blotches and irregular bandings of grey (white-weathering) rock, and numerous small white-weathering specks. Like the Huronian rocks, these dip southerly, and appear to pass beneath the Primordial shales, which skirt the southern shore of the lake. About three miles south of the latter, the Huronian beds reappear in the valley of Ratcliffe's millstream, on the northern border of the more southerly of the two great anticlinal ridges. Here they overlie the Primordial strata, both formations occupying a nearly vertical position, with a slight southward inclination, and both being inverted.

Loch Lomond.

Ratcliffe's Millstream.

Where the stream last mentioned descends from the hills which bound its valley on the south, the Upper Coldbrook strata consist of greenish-grey, red and purple sandy shales and sandstones, while a little to the west upon the same stream, there are, with these, fine grained olive-grey micaceous sandstones, having surfaces spangled with grey mica, red somewhat micaceous slate, and fine grained olive-grey petrosilex. At both points the lower members of the series appear to be wanting, their place being occupied by a ridge of fine grained grey syenite, extending from Negro Lake, near the source of Black River, for several miles eastward into the parish of St. Martin. This ridge, if not intrusive, may be composed of Laurentian rocks, brought to the surface contemporaneously with the folding of the overlying sediments. It probably marks the line of a downthrow or fault, being immediately followed in that direction by the petrosilicious and dioritic beds of the Huronian. These inferior beds, which present different shades of blue, pink and grey, and are in part a petrosilicious conglomerate, are followed on the road alluded to, by considerable masses of fine pink felsites (No. 2), extending to within about four miles of Quaco ; but a short distance westwardly, about the Negro Settlement, the first mentioned dioritic and petrosilicious beds are overlaid by a belt of Primordial strata, which in the valley of Black River intervene between these and another great mass of diorites and felsites constituting the eminence known as Bloomsbury Mountain. In our earlier publications this hill, which forms the western terminus

Syenite ridge.

Quaco road.

Petrosilex and diorite.

Negro Settlement.

of the ridge of land known as the Quaco Hills, chiefly composed of the Huronian strata under consideration, has been referred, from the fact of its overlying the slates of the St. John group, to the Devonian series; but the close resemblance in aspect borne by the rocks composing it to those so largely developed to the north and north east, from which they are separated only by a narrow valley, renders it more probable that the great mass of strata in this hill is of Huronian age, and that, though here apparently resting upon the Primordial strata (which in the valley alluded to dip southerly under Bloomsbury Mountain), they are in reality more ancient than these latter, and are here brought up along a line of fault in a similar manner to those of Ratcliffe's millstream. These rocks are well exposed along the post-road, on the south-western flank of the hill, and are as follows :—

Succession on Bloomsbury Mountain.

There first appears a considerable breadth of compact dark grey diorite, without evident marks of stratification. Beyond this to the south are stratified dark grey diorites, followed by amygdaloital porphyritic diorite. To this succeed other beds of dark grey diorite, covered by fine grained beds containing much hornblende. A grey, sometimes nearly white, micaceous quartzite rests upon the last named beds, and the whole is covered by greenish-grey petrosilicious beds, the latter in many places being filled with irregular vesicles, the sides of which are coated with minute crystals of quartz, calc-spar, and specular iron. The thickness of the stratified deposits visible on this slope of the hill is about 3,000 feet.

Road from Quaco to Sussex.

From the Quaco road, where the Huronian strata have a surface breadth of from four to five miles, the rocks of this series, with essentially the same characters, but forming a belt of somewhat greater width, extend eastwardly, and have been recognised on Vaughan's and Macomber's Brooks, about four miles in the rear of Quaco, and along the old road connecting the latter with Upham and Sussex. On the first named stream the strata consist mainly of dioritic and petrosilicious beds, having a south-easterly dip of from 60° to 80°, but farther north, at Wood Lake, the greenish quartzite beds appear. On Hanford's and Harding's Brooks, the soft red upper sedimentary beds cover the northern slope of the anticlinal ridge. They here dip northerly at an angle of 45°, with a surface-breadth of about one and a-half miles, and are immediately followed by fossiliferous strata of the St. John group, having the same dip. The latter thence occupy the road to a point a short distance beyond where the brook above named unites with the main branch of Hammond River.

Hammond.

At the point last named, Carboniferous sediments appear, which conceal the more ancient strata over much of the district eastward of that above described, in the parishes of Hammond and Sussex. At several points, however, the Huronian rocks rise above these newer sediments. The first of these exposures may be seen a few miles east of that last noted, and just

south of Hammond River, in a ridge of dioritic and petrosilicious rocks, crossing the parish line between Upham and Hammond. This may be continuous with another tract still further east, beyond the sources of the same stream and near the manganese mine of Markhamville. The hills bounding the Hammond River valley on the south at this place, consist of Huronian strata, while the valley itself and the greater part of the northern slope are formed of Lower Carboniferous sediments. In the immediate vicinity of the mines, the older rocks are chiefly the fine grained dark grey diorites, and black or dark grey felsite or petrosilex of Divs. 5 and 6; but about half a mile down the valley, the grey rusty-weathering sandstones alluded to in connection with Div. 2, here heavily charged with carbonate of iron, come out upon the slopes of the hills. The manganese mine is in Lower Carboniferous sediments, occupying a valley between two ridges of Huronian strata, and it may have been from these that ore was originally derived, thin veins of manganese being sometimes found in the dark grey feldspathic rocks which form the more northerly of the two ridges referred to. Both of these ridges present several varieties of grey and dark grey petrosilicous beds, which have sometimes the aspect of a conglomerate, associated with grey and greenish-grey amygdaloidal and compact diorite. Still farther east, in the same general line with the above, similar beds appear about one and a half miles west of Pleasant Lake. Beyond this point we have not observed any undoubted Coldbrook strata, although some beds upon the Pollet River, near the county line between King's and Albert, bear some resemblance to the rocks of this age.

Markhamville

Manganese.

HURONIAN ROCKS OF NORTHERN KING'S AND QUEEN'S COUNTIES.

We come now to speak of the Huronian or Coldbrook strata met with in the belt of crystalline rocks which passes north eastward through the centre of Charlotte County, and thence along the boundary line between the counties of King's and Queen's to and beyond the St. John River. In the county first named the rocks of this age are much obscured by sediments of more recent age, but on both sides of the crystalline belt in the hilly tract between King's and Queen's Counties, portions of this series may be recognized. These are moderately well exposed in the hills about the sources of the Nerepis River, and between Belleisle Bay and Washademoak Lake.

In the parish of Petersville, Queen's County, Armstrong's Corners, at the junction of the south branch (called North Branch) with the main Nerepis stream, is the centre of an irregularly lenticular area occupied by Huronian rocks, which, in a westerly direction, extends across the main Fredericton post-road into the wooded country in the rear of Douglas Mountain. Eastwardly, it covers much of the broken country along the south branch as far as Jerusalem Settlement in the parish of Hampstead. Towards the

Armstrong Corners

Nerepis valley.

western end of this area there are good exposures westward of Armstrong's Corners, in the cross-road leading thence to the Government House on the post-road to Fredericton. At the bridge over the south branch, near where this by-road diverges from the Gagetown road, are ledges of hard dark purplish felsite or petrosilex, porphyritic with small crystals of feldspar, and containing small portions of jasper. Their dip at this point is S. 30° W. < 90°. Further west, numerous ledges of highly feldspathic rock cross the road leading to Government House. They are in part obscurely schistose, but usually compact and without obvious lamination. In color they vary from dark purple to pale green, and in most instances are porphyritic to a greater or less degree. A portion of the rock contains scattered grains of a dark green mineral resembling chlorite. Some loose fragments of purplish-red clay-slate, were also observed. About a mile below Government House, on the Fredericton post-road, a by-road turns off to the westward, upon which, at a distance of thirteen hundred paces from the main road, is a ridge of felsite and porphyritic diorite which has been exposed by the denudation of the surrounding grey slates.

Government House.

Gagetown road.

From Armstrong's Corners the Gagetown road runs easterly along the northern flank of a range of hills chiefly composed of feldspathic and petrosilicious rocks, with compact and vesicular diorite resembling those of the Coldbrook group. These dioritic rocks are in some places filled with nodules or concretionary masses of white chalcedonic quartz, arranged along parallel lines having a general east and west course. To the northward of the above, the red rocks which lie at the base of the St. John group may be seen exposed at intervals in low ledges along the road last named, and in the bed of the Nerepis stream. At Wm. Wood's these consist of olive-grey and purplish-grey clay slates. They dip S. 10° W. < 80°, and are overturned, for they are flanked on the north by shales of the St. John group, and on the south by the Coldbrook rocks alluded to above. On examining some ledges which crop out on the banks of the river, the following succession of beds at the junction of the two groups was observed, in ascending order:—

Succession on Nerepis River.

1. Ledges of fine grained dark grey diorite.
2. Beds of olive-green and purplish-red clay slates, heavily charged with carbonate of iron, and divided by numerous veins of that mineral. These veins of spathic iron vary from four inches in thickness downward.
3. The clay-slates are overlaid by a syenitic rock, consisting of reddish feldspar, an earthy mineral resembling chlorite, and quartz.
4. To the above succeeds a hard purplish fine grained argillaceous rock, abounding in vesicles which are filled chiefly with epidote.

St. John group.

Northward of the hard rocks last named lie the black shales of the St. John group. The width of these Upper Coldbrook rocks exposed on the river, allowing for a fault by which the whole series is repeated, is about two hundred feet.

But little is yet known of the distribution of the Huronian rocks in the district immediately to the eastward of that above described. It is probable, however, that the eastern limit of the lenticular area, referred to above as composed of these rocks, will be found on the road leading from Coot Hill on the Nerepis River to Jones's Creek in the parish of Greenwich, in King's County. On this road, for the distance of about a furlong on the south side of the south branch of the Nerepis, there occur dark purplish porphyritic felsites, which have the aspect of Huronian rocks. They are bordered on the south by Upper Silurian clay slates, and on the north by Lower Carboniferous strata. Slates of Upper Silurian age are also spread over much of the area lying to the southward of that just mentioned, and between it and the granite hills, but at several points along the Harry Lyon road, the more northerly of the two roads which connect the Gagetown road with that above alluded to as extending to Jones's Creek, Huronian rocks come out to view. These are chiefly diorites and felsites, the latter often finely porphyritic with feldspar crystals. Among the rocks occurring along this road are a coarsely porphyritic dark green diorite, and a breccia-conglomerate composed of fragments of diorite and felsite, both very like strata exposed in the anticlinal ridge of Coldbrook rocks south and west of Bloomsbury Mountain, in St. John County. Both the paste and fragments of the breccia in the Nerepis area are porphyritic with small crystals of feldspar.

South branch of Nerepis. R.

Feldspar porphyries.

Near the point where the roads referred to in the last paragraph intersect each other, a few miles south of Jerusalem Settlement, rises a high and precipitous bluff known as Broke-neck Mountain, forming the western termination of a ridge about two miles long, which, presents, at its eastern end, under the name of Blue Mountain, a similarly abrupt character. The rock composing this ridge, as seen in the two eminences just named, as well as upon the road which connects them along its northern flank, is a very hard, flinty, dark grey (light-weathering) petrosilex, associated with beds of fine grained dark grey felsite. Similar rocks form also less elevated ridges lying northward of and parallel to the road last named, their slopes being covered by fossiliferous Upper Silurian strata, which also appear along the northern side of Blue Mountain, and at the base of the high wall of rock which forms its eastern face. Between this mountain and Jerusalem Settlement, the road which connects the latter with Oak Point on the St. John River, passes over a belt of land which is comparatively low, and occupied mostly by sediments more recent than those of the Huronian series, but which is traversed by several ridges, some of which bear much resemblance to the latter. The most marked of these may be seen about two miles north of Blue Mountain, and consists of a compact dark greenish-grey conglomerate, with dioritic and epidotic beds. About half a mile nearer to the mountain, ledges somewhat similar to the above cross the road, and consist of purplish and dark greenish-grey dioritic conglomerate, with pebbles and beds of purple porphyry and fine grained

Broke-neck and Blue Mountain.

Jerusalem.

greenish-grey feldspathic rock. These beds are probably a continuation of those already noticed as occurring along the road from Coot Hill to Jones's Creek on the St. John River.

On the south side of the granite hills in the Nerepis country, the observed rocks of the Huronian series are chiefly felsites or petrosilicious rocks, very fine grained, frequently porphyritic, and usually of black or dark purplish and greyish shades. Hills of such rock occur near the granite in the vicinity of Cunningham Brook, near Eagle Cliff, on the Nerepis River. From this point to Jones's Creek, in the parish of Greenwich, the country has been only partially explored. No rocks of this age were met with through the settlements which lie immediately to the southward of the belt of high land which extends in an easterly direction through the greater part of this parish; but at several points along the road from Jones's Creek to Jerusalem Settlement, which passes around the eastern termination of this elevated tract, rock-masses are exposed which probably belong to the series in question. They consist for the most part of dark grey (light-weathering) and dark purple felsites, but include also a felsite breccia, composed of angular fragments of felsite, sometimes reddish in color, enclosed in a dark feldspathic base. Such rocks may be seen on this road a little south of the boundary between the counties of King's and Queen's, where also occurs a hard grey petrosilicious conglomerate holding large rounded pebbles, from one inch to a foot in diameter, of grey flinty petrosilex. The first named beds, and possibly the last, are connected with a mass of hard fine grained flinty and feldspathic rocks, which cover an extensive area in the neighborhood of Jones's Creek, and to the northward of this stream rise into hills of considerable altitude. The felsites exposed in these eminences, like those in the hills south of Eagle Rock on the Nerepis River, are sub-crystalline in aspect, with rough angular surfaces, the prevailing colors being dull grey to black, but often reddish on exposed surfaces, and sometimes weathering bright red. Near a small lake in the rear of the settlement of Jones's Creek, and along the road which connects the latter with Jerusalem by way of Blue Mountain, the felsites in question may be seen to rest upon beds of coarsely crystaltine diorite, similar to those which in the preceding chapter have been described in connection with rocks of the Laurentian system.

Greenwich.

Felsites.

Jones's Creek.

In the hilly and uncleared region which lies immediately to the eastward of that above described, we have been able to spend but little time. A considerable portion of it is occupied by the belt of crystalline rocks described in the last chapter as coming out on the St. John River below the village of Hampstead. No rocks resembling those of the Huronian series were observed along the northern side of this crystalline belt, but at Long Lake, near its western extremity, and again upon its southern edge, just above Mistake Cove at the head of the Reach, are beds which may be of this age. At the first named point, which lies east of Blue Mountain, the rocks in

Long Lake.

question are dark grey, porphyritic petrosilex (weathering greenish-grey) and conglomerate. They are surrounded by Upper Silurian sediments, and associated with heavy ridges of diorite. Those which occur on the southern side of the crystalline ridge appear to form a narrow belt between the latter and the Upper Silurian schistose rocks and diorite which form the northern shore of the Long Reach, east of Oak Point. They come out upon the river above the head of Mistake Cove, and consist of dark greenish-grey dioritic **Mistake Cove.** sandstones, and very fine grained dark grey slaty silicious beds, associated with some mica-schists and imperfect gneisses. They are in some parts colored green with epidote, and in others contain layers of radiating hornblende. The dip of these beds, is N. 10° W. < 70°.

HURONIAN AND ASSOCIATED STRATA IN WICKHAM, KARS AND SPRINGFIELD.

At many points through the hilly region lying to the east of the St. John River, in the parishes above named, and included between the depression of Belleisle Bay on the one hand, and that of Washademoak Lake on the other, strata may be seen bearing much resemblance to those of the Huronian series in the regions already described. Three traverses of this hilly tract have **Traverses.** been made, in each of which the bulk of the rocks in question resemble those of the Coldbrook group—Nos. 3 to 6,—but associated with these are others, some of which appear to be of still greater antiquity, while others again are schistose argillaceous rocks, which may be of Upper Silurian or Devonian age. Our examinations in this quarter have not been sufficient to distinguish in all cases the members of these different groups, which are accordingly considered together in the following details of the region.

The first of the traverses alluded to was made along the eastern bank of the St. John River, between the entrance of Belleisle Bay and Golding's Landing, in the parish of Greenwich, in Queen's County, a distance of about four miles. The course of the river is here nearly north and south, or at right angles to the strike of the beds, which are well exposed in an almost continuous succession of low bluffs.

A peninsula about a mile wide, and forming the most southerly part of the parish of Kars, separates the waters of Belleisle Bay from those of Tenant's **Kars.** Cove, a small indentation of the St. John River. The rocks composing this peninsula are greenish-gray and purplish light-weathering feldspathic schists, which are probably the same as those of the Coastal group, and will be more fully considered in the succeeding section. They are separated from the Coldbrook rocks by a belt of dark grey rusty and somewhat plumbaginous shales, met with near the head of Tenant's Cove, from which this indentation has probably in part been excavated. The northern side of the same cove is composed of much harder rocks, forming the more southerly portion of the series of bluffs to which reference has been made. The following measurements have been roughly taken by pacing along this shore, between Tenant's Cove

Section between Tenant's and Jones's Cove.

and Jones's Cove. For a quarter of a mile from the entrance of the cove, on its northern side, there are no exposures. Corrugated grey shales then appear, associated with schistose dioritc beds, and dipping N. 20° E. < 60°. There is then another space of 500 feet without exposures, beyond which the succession is as follows :—

	FEET
Very hard, dark grey, compact, and somewhat slaty diorites, and grey crystalline dolomite, portions of which are an earthy buff-weathering rock, with specks of chlorite	87
Diorites, containing much quartz, some of which is rather coarsely crystalline, frequently exposed in a space of	1,400
Greenish-grey chloritic schists. Dip N. < 60°	100
Hard fissile black slate. Dip N. 20° E. < 70°	25
Hard bluish slate, more compact than the last, and more silicious... ...	15
Alternations of fine fissile black slates, and compact dark blue slates, with thinner layers of light gray sandstone, and one of gray chloritic slate. Dip in the latter part, N. < 70°	115
Hard greenish-gray chloritic slate	20
Grey micaceous shales (dip N. 20° E. < 70°) and grey rusty somewhat micaceous clay-slates (dip N. 10° E. < 50°), separated by an interval of about 275 feet, in which are 60 feet of diorite	375
Measures concealed	200
Grey rusty micaceous shale, dipping N. 20° E. < 60°, and including about 60 feet of diorite	500
Measures concealed	125
Pale grey, more or less shining argillites, (including two small intervals, in which the measures are concealed.) Dip N. 20° W. < 80° ..	800
Pale gray argillites, including thinner beds of greenish-grey, sometimes sandy shale	250
Measures partly concealed, but probably argillites, which appear in the hills above	850
Pale gray shining argillites. Dip N. < 80°	250
Grey lustrous shale, covered with dark green films	25
Dark grey shale, with elongated oval spots	8
Schistose rock, in part like the last, but mostly a fine grained diorite ...	60
Measures concealed	12
Gray gneissoid rock, covered with dark chloritic spots	25
Measures concealed	30
Grey gneissoid rock like the last, but more shaly	60
Grey shale...	80
Grey gneissoid rock, with chloritic spots. This becomes coarser, and passes into a porphyry, weathering with prominent light-colored angular feldspathic blotches	55
Measures concealed, in part greenish-grey schistose rock, with chloritic films and grains of quartz	20
Green chloritic and greenish-grey feldspathic schists, both with films of chlorite, the latter part holding small round pebbles. Dip N. 10° W. < 90°	60
Gray porphyritic gneiss, similar to that described above	125
Dark green chloritic shale. Dip N. 10° W. < 90°	80

Dark green chloritic slate, like the last, but coarser, weathering with large and numerous white lenticular patches of steatite, mingled with films of dark green chlorite	60
Compact dark grey, fine grained silico-feldspathic rock	30
Compact porphyritic rock, of a greyish color, with shades of green and purple, and yellowish-green spots	25
Gray shales, with shades of green and purple, and having dark green oval films, the latter part fine and fissile. Dip as above	175
Diorite	7
Greenish-grey chloritic shales	180
Coarse grey shale, like the last, but without dark green films	125
Coarse porphyritic rock, like that described above	18
Shales of dark green and grey colors, the former with dark oval spots, the latter harder and more silicious	500
Hard grey rocks, of which some portions are schistose, and others compact, quartzose, and somewhat dioritic ; the latter part dark green chloritic shales	125
Measures concealed. The hills above the line of section corresponding to this space are composed of rocks similar to the last	450
Grey and dark grey argillites. Dip N. $< 70°$	10
Greenish-grey and grey argillites	200

The argillites which terminate the above section, come down to the river in the form of a low point, making the southern side of the indentation known as Jones's Cove. This cove forms a portion of a triangular area, having a base of about a mile in width, and consisting mostly of meadow land, which intervenes between this point and the southern boundary of the County of Queen's. We have not examined the interior of this indentation, but it is probable that it is occupied by slates, such rocks having been seen for some distance along its southern shore, as well as in the high lands which overlook it from the north.

Jones's Cove.

The first rocks met with on entering Queen's County are grey shining argillites, similar to those of Hampstead, on the opposite side of the river. They are in nearly vertical beds, having an easterly course, and are exposed upon the southern edge of a nearly flat terrace-like series of hills, which, for two miles or more above this point, are covered with superficial deposits, and afford no exposures of the underlying rocks. It may be worthy of mention that this area, thus obscured, is nearly opposite to that which, on the opposite side of the river, near Spoon Island, is occupied by the grey granites of the Hampstead quarries. The first exposures of rock on the eastern side of the river, to the northward of those described, are to be seen near a small ravine, about a mile below Golding's Landing, and nearly opposite the foot of Long Island. They consist of finely bedded greenish-grey shales, immediately to the north of which are beds of greenish grey fine grained granitoid gneiss, associated with chloritic gneiss of the same color, and chloritic schists. The dip or cleavage of these beds is S. $< 90°$. In the bed of a small brook which traverses the ravine above mentioned, and a little to

Golding's Landing.

Argillites.

Shales of St. John group.

the north of the last named beds, are exposures of rather soft bright green thick bedded and somewhat unctuous slates, dipping N. 30° E. in a nearly vertical attitude. These slates are probably connected with a series of argillites, also vertical, but paler in color, which form a ridge on the northern side of this ravine, and separate it from another similar depression a few rods to the northward. In the hills which form the upper side of this second ravine are ledges of conglomerate, chiefly made up of pebbles of purplish-brown felpar or petrosilex, intersected by numerous veins of ankerite, and having a slaty structure conformable to the schistose beds upon which they rest. These latter are finely bedded greenish-gray argillites, dipping about S. $<70^\circ$, and are associated with dull greenish-grey pale-weathering schistose feldspathic rocks, and slaty conglomerates, the latter containing fragments of ankerite which by weathering are converted into ochreous spots. In the same ridge with these, but to the northward of them, green and purplish-red argillites, speckled with scales of grey mica, come into view, with a dip S. $<90^\circ$. A depression of no great width then succeeds, probably occupied mostly by dark gray and black finely-bedded shales, fragments of which are abundant in the soil, and which are exposed on its northern side in numerous ledges over a breadth of a hundred yards. These shales, which are quite soft, fissile, and easily broken, resemble those of the St. John group, and will probably be found to contain characteristic fossils, although a diligent search for these failed to discover them to us. The dip of these beds is S. $<80^\circ$.

Chloritic rock and felsites.

Golding's Corner.

A few feet to the northward of the black slates last mentioned are thin beds of soft dark green schistose chloritic rocks clouded with purple, which intervene between them and a mass of bright red and pale grey crystalline felsites, which weather almost white. These feldspathic rocks form the southern side of a rather prominent ridge running out to the St. John River about half-a-mile above the foot of Long Island, the remainder of the ridge being composed of porphyritic and dioritic fine grained rocks, portions of which are of a dull green color, highly feldspathic, and replete with small vesicles, and others dark purple, diversified by white amygdules and by spots of epidote. The aspect of these rocks is that of the Coldbrook group in the Huronian series, and their breadth at this point about one hundred yards. A few rods to the north are dull grey sandy shales, and argillites, alternating in narrow belts, the surfaces of which are marked by numerous thin and branching layers of a darker color, some of which resemble the impressions of fossil plants, but are destitute of structure. These arenaceous beds, which dip N. $<70^\circ$, occupy, together with a small ridge of diorite, the remaining space to Golding's Corner.

Between the traverse above described and the second, made in the western part of the parish of Springfield, is an interval of about eight miles, in which rock exposures are for the most part too limited and disconnected to

throw much light on the geological structure of the region. So far as observed, their general character is similar to what has been described above, near the St. John River, but they include also some beds not observed upon the latter.

The best exposures to be met with in this district are to be found among the hills upon either side of the London Settlement, about three miles east of Golding's. Along the road which connects these two points are numerous outcrops of grey and dark grey schistose feldspathic rocks and grey slate, similar to those near Golding's, and in like manner associated with thinner beds of hard grey sandstone and diorite, being probably of Upper Silurian or Devonian age. Their dip, about one and a half miles from the river is S. 30° E. < 40°. On entering the London Settlement, the same road, previously running easterly, turns to the south, extending along a valley through which flows a small stream connecting with Jones's Cove on the St. John River. Where the stream in question enters the settlement at its northern end, two rather prominent ridges may be seen, one on either side, which are composed for the most part of a hard, pale liver-grey, white-weathering feldspathic quartzite, the dip of which is apparently S. <45°. These rocks bear some resemblance to those of the ridge below Golding's, on the St. John River, but lack the red tint of the latter, and are much more silicious, some portions being flinty and porphyritic, of a very dark grey, weathering to a pure white color. Along the southern slope of this ridge, and separated, if at all, by a very narrow interval, are dull dark grey and somewhat sandy argillites, the surfaces of which are covered with small scales of mica; their dip is S. <80°. Descending to the bed of the brook, a mass of pale grey, light-weathering quartzite like that of the hills, and about thirty feet in thickness, may be seen enclosed between these argillites and others to the south, which are more finely bedded, and of darker, almost black, colors, as well as very fine and fissile. These are probably the same as the dark shales seen on the St. John River, but are not well exposed at this point. Large blocks of purple slate are abundant in the soil which covers these hills. No ledges of the latter were seen at this point, but in crossing the uplands, a little to the south and on the eastern side of the stream, beds of this character come into view, and appear to have a considerable thickness. Their dip is S. <60°. A few rods further in the same direction is a low ridge of diorite, succeeded after a short interval by grey coarse-grained quartzites, which are pyritous and rusty-weathering, and in which are contained small quantities of copper-pyrites. With these quartzites are dark green feldspathic sandstones containing much disseminated chlorite, in thick beds, together with thinner beds of fine grey splintery shales. Crossing a by-road, which here runs to the eastward, a high bluff may be seen near the middle of the settlement, composed of pale grey light-weathering feldspathic rock, which is rather coarse grained, and in part a feldspathic sand-

London Settlement.

Copper pyrites

stone. Ridges similar to the above may also be seen on the opposite or western side of the valley, where, through the remainder of the settlement, the strata are better exposed than on the eastern side. The most northerly beds visible here are the dark green chloritic sandstones alluded to above, having a breadth of several rods, and forming very hard and massive beds of uniform aspect, and without evident stratification. To the south of these, but separated by an interval of fifty rods, are beds of similar composition but more finely grained and schistose. There is then another interval, beyond which appear the lighter colored, somewhat sandy beds last alluded to on the opposite side of the valley. Two ridges of these rocks, having a course E. 10° N. and separated by a narrow valley, here overlook the mill-pond and bridge at the southern end of the settlement. Portions of this rock are conglomerates, made up of fine grained, greenish-grey feldspathic fragments, containing pale grey amygdules, which by weathering give to the mass a vesicular aspect. These rocks recall those seen near Jones's Cove, on the St. John River, and are similarly associated with greenish-grey schists, covered with dark green films of chlorite. A few ledges of the latter may be seen near the head of the mill-pond, followed at McCrae's mill by bright purple and purplish-red argillites, and fine grained grey and purplish-grey sandstones. These latter, on exposed surfaces, are conspicuously banded with narrow streaks of a paler somewhat greenish color. The dip of the more schistose portions is S. 10° E. $<40°$, the slaty cleavage, which is strongly pronounced, being N. $<80°$.

The mill last alluded to is about a quarter of a mile northward of the boundary line between King's and Queen's Counties. Where the road connecting London Settlement with Tenant's Cove crosses this line, fine fissile and glossy grey argillites may be seen, with a dip or cleavage N. $<90°$. No other rock exposures are met with in this direction until the point is reached where the same road is intersected by that known as the Base-line road, and which traverses the central part of the parish of Kars. Just beyond the Baptist church, which stands near the intersection of these thoroughfares, dull and black rusty-weathering slates may be seen, apparently with a southerly dip, succeeded by massive, somewhat dioritic rocks of a dark green color. Still further in the same direction (near the house of Wm. Urquhart) are ledges of hard dark greenish-grey chloritic grit, followed closely by pale grey and greenish-grey micaceous shales, dipping N. 20° E. $< 60°$. Midway between this point and Tenant's Cove, where four roads meet, are beds of hard grey feldspathic rock. These, with black slates and chloritic schists, are the same with those seen on the shore of the St. John River, above Tenant's Cove. The rocks about this latter and thence to Jenkins's Cove, have already been described.

Kars

Through the remainder of the parish of Kars we have made but few observations, the rocks being mostly concealed from view. So far, however,

as these are visible, they indicate an extension to the eastward of the formation already described in the vicinity of the St. John River. Near the south-eastern corner of the parish are ridges of dark grey, slaty feldspathic rock and diorite, dipping N. 10° E. < 70°,—probably a continuation of the beds near Tenant's Cove. To the north of these, on the Base-line road, near the centre of the parish, are greenish-grey chloritic schists and grey argillites, similar to those about Jones's Cove. Still further north, near the boundary line between King's and Queen's Counties, the strata resemble those of the Coldbrook and Coast series, being probably a continuation of the beds described near Golding's Corner, and in the London Settlement. These latter rocks may be seen at several points along the road which connects the first named locality with the Shannon Settlement in the parish of Wickham, and again a little to the south of the latter, on the Lawson road, which connects this settlement with the Base-line road in the parish of Kars. At the first named point they consist of dark green feldspathic rocks of Huronian aspect, associated with grey argillites showing narrow alternating hard and soft layers, which are seamed with quartz, and dip S. < 80°. Both are overlaid and partly concealed by pale red fossiliferous limestones of the Lower Carboniferous formation. Not far from these limestones, on the road which here runs westerly towards the St. John River, are grey shaly sandstones, also of Carboniferous age, which are filled with poorly preserved plant remains, and dip W. 25° S. <50°. From beneath these sandstones, in the bottom of a depression through which runs a large brook, grey and purplish, somewhat lustrous argillites come into view, dipping S. < 40°. Still further west in the same direction are ledges of pale grey feldspathic grits, dipping S. 20 W. <50°. A considerable interval occupied by argillites, separates these beds from pale grey, white-weathering feldspathic quartzites, which are very silicions and filled with quartz veins. These are probably the same as those of the London Settlement. Feldspathic grits similar to the above, but in part chloritic, may also be seen on the Lawson Road, about half a mile north of the Queen's County line, being probably a continuation of the above, and having the same dip. They are in like manner associated with purplish feldspathic beds, somewhat mottled with grey, and having seams filled with red ochre, also with red rubbly slates. To the south of the grits, on the last named road, are grey and pale reddish-grey, light-weathering, rather coarse grained felsites, with disseminated black and glistening minute crystals, succeeded in the same direction by a conglomerate composed of grey feldspathic pebbles in a greenish-grey slaty paste. (Dip? S. 20° W. < 80°.) Still further south, near the house of John Lawson, in the north-eastern corner of the parish of Kars, are a few small outcrops of fine fissile dark grey slate, and bluish-grey slate. This is not far north of the point where the Lawson road intersects the Base-line road. Near where the latter crosses the parish line between Kars and Springfield, greenish-

Lawson Road.

grey sandy felsites again appear, and beyond them, at Daniel Morrill's, in the last named parish, ridges of hard and compact dark green feldspathic and dioritic rock, like that of the Coldbrook series. This is but a short distance westward of the second line of traverse to which reference has been made, and which is afforded by the valley of Spragg's Brook and its tributaries.

The stream last mentioned flows into Belleisle Bay, near what is known as the Point, at its head. About two miles to the north of this locality it divides into two branches, the more westerly flowing along a valley through which runs a road from Belleisle Point to the Washademoak Lake, in Queen's County. Along this road and in the bed of the stream may be seen a very complete section of the rocks in this district, which include some strata not met with further west.

Belleisle Point.

In ascending the bed of the brook from Belleisle Point, the first rocks met with after passing the Carboniferous conglomerates with which the valley of Belleisle Bay is chiefly filled, are dark green feldspathic rocks which are partly schistose and partly a conglomerate. Associated with these are other somewhat slaty feldspathic beds, but of lighter (pale green and pale red) colors, some of which are very ochreous, their dip varying from N. 40° W. $<60°$ to S. 50° E. $<40°$. To the north of the latter, and apparently dipping beneath them, are soft, finely bedded and somewhat glossy dark grey fissile shales, and dark green chloritic schists, dipping S. 30° E. $<60°$, followed by more massive dark green chloritic rocks, in which the bedding is less obvious. The measures are then concealed for nearly a quarter of a mile. Beyond this space, which is partly occupied by a bend of the stream, the latter flows between high hills, composed in part of a fine grained greenish, somewhat schistose rock, holding small fragments of purple slate. This is but imperfectly exposed in the hills, and in the bed of the brook does not appear, the first beds met with in the latter, and nearly midway between the hills, being dark green glossy argillites, which exhibit numerous and sharp corrugations, more than ten folds being visible within thirty feet measured across the line of strike. These argillites include some thin beds of a purple color, and are separated by about ten feet of massive dark green and epidotic diorite, from a thick mass of bright red and purple slates, dipping N. 60° W $<90°$. Near their contact with the diorite, these slates are dark-colored, and veined with feldspar parallel to the bedding. A bend of the stream then goes back on the green slates, which here appear to dip southerly (S. 40° E. $<80°$). They include a lenticular bed, from four to six inches in width, of pale pink white-weathering porphyritic felsite, and grey slaty dolomite. More green chloritic and bright red slates then succeed, also including a small bed of grey slaty felsite. Farther up the stream massive yellow-grey felsites come into view, succeeded by grey slates covered with spangles of mica, and dipping S. $<70°$. These grey slates then occupy the stream for some distance, being mostly thick bedded,

Chloritic rocks

Red and purple slates.

Dolomite and felsites.

but including also some beds which are finer and of a purplish color, and at one or two points, thin beds of felsite. Higher up the stream these felsites again appear in force, being fine grained and of a pale yellowish-grey color, and, with some included beds of diorite, extend to the forks of the stream just below W. C. Davis's grist-mill. From this point the road follows the more westerly branch. Just beyond the bridge, at the junction of the two streams, grey and greenish grey feldspathic slates with ochreous joints appear, with a southerly dip (S. 20° E. < 60°), followed, after an interval of a few rods, by rather thick bedded greenish-grey argillites, the dip of which is N. 30° W. < 70°, becoming reduced in a few yards to 60°. A few rods beyond, where the road again crosses the stream, fine grained and thick bedded grey and purple argillites appear, which are jointed and have a strong slaty cleavage, the dip being apparently S. 40° E. < 40°. These argillites, with others of paler color, and which are more or less ochreous, occupy most of the space between the bridge last noted and still another, where the road under consideration is joined by the Base-line road. At this point are ledges of hard and massive feldspathic rocks of grey and greenish-grey colors, which are partly fine grained argillites and in part grey feldspathic sandstones. These are, probably, the same as the beds seen to the westward of this point in the parish of Kars. For about three-quarters of a mile beyond the bridge last alluded to, the stream runs through meadow lands, which upon the eastern side are bounded by a succession of low rocky bluffs. About one-half of the strata disclosed in these hills are soft rubbly and somewhat splintery dull grey shales and dark grey slates, not unlike certain beds which, at Jones's Creek, on the Long Reach of the St. John River, contain Upper Silurian fossils. No organic remains, however, were met with here. The beds are folded and irregular, but appear to dip about N. 60° E. < 40°, and to be overlaid by a series of hard grey grits, which are also in part interstratified with the slates. Further up the valley, and forming a part of the same line of bluffs, are hard rubbly greenish grey rocks, and green fine grained diorites with ochreous joints. Near the house of Edward Spragg these dioritic rocks are succeeded by greenish-grey schistose feldspathic rocks, like those of the Coldbrook series, forming a low ridge, on whose northern flank is a thick body of pale greenish-grey shales, having a dip or cleavage S. < 70°. Another low ridge then succeeds, in which greenish-grey schistose rocks may be seen enclosing a mass, about fifty feet in breadth, of highly feldspathic light-weathering rock, which in some parts is fine grained and homogeneous, approaching a felsite, and in others is granular and porphyritic, while other portions again contain greenish-grey epidotic pebbles or concretionary nodules. Similar pebbles or concretions are also contained in some of the enclosing schistose beds, which thus acquire the aspect of coarse conglomerates; but a little to the north these again become more finely grained and uniform, being mostly pale grey light-weathering finely bedded argillites, but

Felsites.

Argillites.

Micaceous and chloritic schists. sometimes of darker colors, or of coarser texture. Among these schistose rocks, which have here a breadth of a mile or more, are some which are micaceous and others chloritic, resembling in aspect the strata described on a preceding page as occurring on the St. John River. near Tenant's Cove. The dip throughout the series varies from S. to S. 10° W. < 80°—90°. About a quarter of a mile south of the county line, the strata in question pass beneath sediments of the Lower Carboniferous formation, consisting of coarse brownish-red conglomerates dipping N. 40° E. < 20°; but about half-a-mile north of the same line, a ridge of the older rocks again rises to the surface, consisting of grey fine grained feldspathic sandstone.

It has been stated in an earlier portion of the Report, that near the northern part of the parish of Springfield, and a few miles to the eastward of the traverse above described, there is a belt of crystalline rocks, consisting mainly of coarse grained diorite, containing magnetic iron, of which the length is about six, and the breadth from one to two miles. On the northern side of this crystalline belt the older rocks are mostly concealed from view by woods or covered by Carboniferous sediments, but southward of the same tract these are better exposed, and have been observed at intervals as far eastward as Kierstead Mountain.

Scotch Settlement. The only rocks which we have had an opportunity of observing in the first named tract, are those which appear in the immediate vicinity of the diorite belt along the road which runs easterly from Scotch Settlement and Sunnyside Lake. About a mile eastward of this sheet of water, a few ledges appear near the road, consisting of a greenish-grey conglomerate, containing rounded pebbles of very fine grained dioritic felsite, imbedded in a sandy feldspathic paste, associated with more compact and homogeneous beds (feldspathic sandstones), some of which are schistose. These beds are separated by a few rods only from the crystalline belt to the south of them. A little further to the eastward, grey sandy argillites appear, and may be seen at intervals for a quarter of a mile or more. They resemble those which occur just south of the coal-field on the western side of the St. John River, and which may be of Devonian age. The road is here distant about one furlong from the crystalline belt, but after an interval of a mile or so, again approaches the latter. Near where it crosses a small brook, a tributary of the Pascabec stream, a contact of the crystalline rock with that of the adjoining formation may be seen.

Contact of formations. The latter here consists of a dark greenish-grey somewhat slaty fine grained feldspathic schist, having a dip or cleavage S. < 80°. The breadth exposed is about a rod, the rock along its southern edge appearing to graduate into diorite, and being cut by dioritic and granitoid veins. Just north of the feldspathic schist are exposures of dark grey and black, rather fissile shales, which are much corrugated.

The best and most complete exposures of the rocks on the southern side of the crystalline belt of Springfield, are those furnished by the numer-

ous streams which here flow southwards to the Pascabec River and Belleisle Bay.

The first of the streams in question to which we shall call attention, is that which unites with the Pascabec River at Belleisle Corner. The first rock exposures met with in ascending this stream, are about one mile from its foot, where, in the bed of the brook, are ledges of fine grained dark green dioritic and epidotic rocks and coarse brownish-red sandstone. Much of this rock is a feldspathic grit, consisting of fragments of felsite, varying from the size of a pea downward, imbedded with scales of chlorite in a yellowish green feldspathic paste. With these beds are brownish-purple dolomites, seamed with sparry veins, and holding much peroxide of iron. No distinct bedding is apparent in these rocks, but the bands of color by which they are diversified have an approximately east and west course. These beds are exposed in the bed of the stream for about twenty rods, becoming in the latter part of this space somewhat coarser, and containing pebbles or concretionary masses, which, like the paste, are highly feldspathic. The rock, as before, exhibits various shades of green and purple, being filled with epidotic matter, and traversed by large yellowish-green epidotic seams. These coarse rocks form the bed of the stream for a quarter of a mile, the apparent dip being S. 60° W. $<$ 40°. There are then no further exposures for a similar distance, beyond which the last beds observed upon this stream, nearly two miles from Belleisle Corner, are hard grey feldspathic grits.

Belleisle Corner.

Dolomites.

A more complete succession of the rocks in this district than that above described may be seen on Scovil's Brook, a stream of some size having its source within the crystalline belt to which reference has been made, and thence flowing southwards, just west of the elevation known as Bull Moose Hill. The first rocks visible in the valley of this stream, are at the foot of the hills, about a quarter of a mile in the rear of the highway, and consist of greenish-grey feldspathic rocks bearing some resemblance to those of the stream described in the preceding paragraph, but more distinctly bedded, the dip being N. 20° W. $<$ 60°. Rocks of similar aspect may be seen between these two water-courses among the hills in the rear of the residence of Mr. W. B. Scovil. An interval of about twenty rods, in which there are no exposures, separates the last named beds from a series of coarse and rather thick bedded feldspathic shales with micaceous layers, associated with hard grey and reddish-grey feldspathic sandstones and dolomites, dipping N. 10° W. $<$ 60°. These are followed by another interval of about fifty rods, beyond which, greenish-grey epidotic rocks, like those of the stream last described, again appear. Still further up the stream, but separated from the last by a space of about a quarter of a mile, are ledges of hard grey somewhat micaceous sandstones, dipping N. $<$ 70°, and associated with fine grained bedded diorites, and very fine grained grey sandstones, having a similar dip. These are exposed,

Scovil's Brook.

with very regular bedding, for a space of about twenty rods. An interval of about the same length then succeeds, beyond which strata of a similar character are again met with, the dip becoming reduced to N. $< 30°$. This would appear to be near the centre of a synclinal fold, for in ascending the stream the next beds met with, at a distance of about forty rods, are grey and dark grey, very fine grained feldspathic sandstones, dipping S. $< 60°$. These are associated with hard greenish-grey fine grained feldspathic sandstone, filled with fragments of felsite and scales of chlorite, and seamed with white quartz. The point where these rocks occur is not far from the forks of the stream. In ascending the west branch of the latter, coarse diorites of the crystalline belt are almost immediately met with, and are again exposed in numerous ledges over the adjacent fields on the farms of Eli Northrup and H. Delong.

It would thus appear that this belt of coarsely crystalline diorites is flanked upon either side by grey petrosilicious rocks, into which, at one or more points, veins of the former may be seen to penetrate. It is not yet certain to what horizon these feldspathic and schistose beds should be referred, but it is probable that they are Huronian. Near the contact of the two formations on the southern side may be seen a few ledges, poorly exposed, of hard grey quartzose gneiss.

Bull Moose Hill.

The eminence known as Bull Moose Hill is composed of Lower Carboniferous sediments, which rest unconformably upon the older rocks. Upon the road which runs immediately in the rear of the hill, these latter may be seen, consisting in part of grey porphyritic felsites, and in part of greenish-grey sandstones. A little to the east, where the same road descends to the valley of Northrup's mill-stream, are bluffs composed of fine grained diorites, associated with light colored felsites and grey sandy shales, and to the north of these, yellowish-grey feldspathic sandstones and grey chloritic gneiss. From near this point a road runs north-easterly, and about a mile to the south of the crystalline belt, entering the parish of Studholm near where a small stream crosses the boundary between this parish and that of Springfield. No rocks were observed along this road; but on the stream alluded to, known as Henderson's mill-stream, good exposures of the latter may be seen. The first beds visible near the mill are soft and somewhat ochreous grey shales, followed by thick beds of compact pale yellowish-grey sandstones, with divisional planes (bedding ?), having a dip W. $< 80°$. In descending the stream these rocks are found to have a breadth of about twenty rods, but include some thinner beds of hard, fine grained grey dolomite and argillite. Towards the end of this space the slaty beds become more frequent, and include some which are of a dark grey color. Still further to the south hard grey sandstones may be seen, alternating in beds of two or more feet in thickness with grey and dark grey slates, the dip being easterly, but with many irregularities and numerous folds. The last rock seen in this direction was a grey feldspathic sandstone.

Henderson's mill-stream.

The stream upon which the above observations were made, is the more westerly branch of a larger stream forming one of the principal tributaries of the Pascabec River. Through the valley occupied by the eastern branch, the road above referred to runs for several miles, the road and valley being both separated from the main valley of the Pascabec by high and broken ridges. A partial traverse of these ridges was made at a point about midway between Henderson's mill and the main road which runs north from Callina Corner. The first beds met with on the northern side of this traverse form low bluffs along the southern bank of the stream, and consist of hard yellowish-grey rusty-weathering sandstones, which are seamed with quartz and dip N. 20° W. < 50°. These sandstones are similar to those described in the preceding paragraph as occurring near Henderson's mill. The next beds which appear in ascending the hills to the south, and separated by about forty rods from the last, are hard dark grey pale-weathering felsites which resemble some portions of the Coldbrook group. They are in part massive and without evident stratification, but in other portions are more distinctly bedded, and include compact sandy shales, often weathering of a purplish-grey color, and numerous masses of schistose fine grained diorite. At one or two points on the slopes of these hills, purple slates may be seen associated with the above named rocks, but including also small beds, from one to two feet in thickness, of hard greenish-grey sandstones. Still farther to the south, and over the summit of the ridge, are hard dark grey massive feldspathic rocks, resembling those of the Coldbrook group described in preceding pages as seen on the Nerepis River in Queen's County, some of the beds being coarsely porphyritic. This ridge is separated from another, near Callina Corner, by a low valley through which runs a branch of Belleisle Creek. In crossing this second ridge and the intervening depression, the only rocks met with were brownish-red conglomerates of the Lower Carboniferous formation, exposed in broad and nearly horizontal layers. Pascabec River.

The hills which form the more northerly of the two ridges described above extend to the eastward for several miles. Near the point where the road which traverses the valley on their northern flank unites with the main road running north from Callina Corner, rocks of somewhat similar character are again met with. These consist, for the most part, of dark greenish-grey felsite, which is exposed in broad ridges over a considerable area; but include also some beds of grey dolomite and, probably, also purple slates, fragments of the latter being abundant in the soil with which some of the ledges are covered. Immediately to the northward of these rocks, on the first named road, are some poorly exposed ledges of grey and dark grey slates, some of which are very finely bedded. Their attitude is nearly vertical, with a slight inclination northward. On the southern side of the same ridge, ledges of reddish somewhat granitoid feldspathic sandstone are exposed in a small brook near the house of Geo. Holmes, consisting in part of a fine grained Region north of Callina Corner.

grey feldspathic rock, which is porphyritic with numerous red feldspar crystals and a few grains of quartz, and in part of a similar rock containing an admixture of somewhat unctuous talcoid or chloritic matter, and possessing a slightly schistose structure. These beds are a little more than a mile to the northward of Callina Corner, beyond which, in this direction, our observations have not extended.

General conclusions.

In reviewing the general character and relations of the rocks above described in the parishes of Wickham, Kars and Springfield, the resemblance which many of the strata bear to those of the Huronian series is apparent. To the former horizon are probably to be referred the red granitoid rocks described in the preceding paragraph about the head waters of the Pascabec River, together with the great mass of dioritic and feldspathic rocks which lie to the northward of them, and perhaps the somewhat similar strata met with to the westward on either side of the crystalline belt in the parish of Springfield, and in the London Settlement. The felsites observed on Scovil's Brook may be a part of the same great formation. The red and purple sediments, which are in each case associated with these rocks, appear to be the same as those described in connection with the Huronian series on the Nerepis River in Queen's County. The chloritic rocks seen along the eastern side of the St. John River, about Tenant's Cove and elsewhere in the parish of Kars, are also probably Huronian. The position of the dolomites, grey feldspathic sandstones, etc., which are so widely distributed through the region under discussion, is uncertain; but it is probable that they come between the chloritic rocks and the red conglomerates of the Huronian series. In their pale grey color and ochreous character they however bear some resemblance to the beds which on the Nerepis River have been described as containing spathic iron, and are in a similar manner succeeded by a body of soft grey and dark grey shales, which may be the equivalents of the St. John group. No great body of these latter has been observed, but the localities in which they occur are generally in the bottom of depressions from which, in conseqeuence of their softness, they may have been in great part removed. Should this view of the relations of the different groups here represented be correct, the great belt of crystalline rocks in the parish of Springfield, if not intrusive, may be a boss of the older Laurentian system surrounded by Huronian and Primordial strata.

The relations of the older rocks in the district under discussion are much obscured by the presence of more recent sediments, consisting mostly of pale grey and green argillites in nearly vertical beds, some of which are of Silurian and others possibly of Devonian age.

HURONIAN ROCKS IN WESTERN CHARLOTTE COUNTY.

In the western part of Charlotte County there are but few rock masses exposed which can with certainty be referred to the Huronian series, owing

to the limited outcrops of strata of this age, and to the fact of there being here a more recent series (the Mascarene series), of which a part bears lithologically a close resemblance to the Huronian. Certain heavy masses of fine grained, purplish-black and dark grey felsites, such as may be seen in Troak's Mountain near the village of St. George, and at one or two points along the Mascarene shore, as well as extensive outcrops of diorite in the same district, are probably of this age. These and other heavy masses of felsite, of lighter colors, (usually reddish and weathering bright red) which often contain epidote and specular iron, found at different points about the shores of Passamaquoddy and Cobscook Bays, will be more fully described in connection with the Mascarene series. St. George.

In the Piskahegan Settlement, on the north side of the granite area on the Magaqudavic River, there is a low ridge of fine grained red felsite, holding grains of quartz and spots of epidote, enclosed by grey micaceous slates and dark grey argillites, which may perhaps also pertain to the Huronian series. Piskahegan.

HURONIAN ROCKS OF THE COASTAL GROUP.

THREE narrow tracts of country bordering the Bay of Fundy, and a long strip of land intervening between the ridge of crystalline rocks which passes through Charlotte County and those of the Kingston group, are occupied by sediments in which no organic remains have been observed, but which have been found to overlie, at several points, strata of Upper Silurian and Lower Devonian age. Hence, those occurring along the coast were, in our report on the geology of Southern New Brunswick, described in connection with the Devonian rocks of St. John County, under the denomination of the Coastal group, Dr. Hunt, however, who has examined a large number of specimens collected from these rocks, and has visited a part of the districts in which they occur, is of opinion that their lithological aspect is such as to indicate much greater antiquity. In the presence of diorites, felsites and other crystalline rocks, he finds this series to resemble the Huronian strata of St. John County. Portions of it do indeed correspond in the appearance of the beds to the Huronian of that county, but the series of the coast is much more voluminous than the resembling parts of the Coldbrook group, and contains conglomerates, limestones, micaceous slates, feldspathic grits, etc., which have not been recognized among the Huronian rocks of St. John County, first described as the Coldbrook group. We have, consequently, here separated these coastal strata from the better known Huronian rocks. Position. Character.

Our knowledge of the relations of the different members in this Coastal group is at present not sufficient to enable us to present their sequence with certainty. The following, however, are the principal groups comprised under this designation :— Sub-divisions.

Red felsites and conglomerates.

Grey limestones and grey clay-slate ? (perhaps accidentally intercalated.)

Grey chloritic grits and schists.

Micaceous slates and grey dolomite.

Green and red clay-slates and diorite.

First tract. One of the tracts alluded to, bordering the Bay of Fundy, is that extending from Beaver Harbor to L'Etang Harbor, and thence through portions of the chain of islands, known as the Western Isles, which separate the waters of Passamaquoddy Bay from those of the Bay of Fundy. Rocks which are probably an extension of these, appear in the interior on New River, near the eastern boundary of Charlotte County, and through them probably connect with the Coastal Huronian rocks about the St. John River in King's County.

Second tract. The second tract is that extending from Negro Harbor, near Beaver Harbor, to Lepreau Harbor. At Negro Harbor the lowest beds are dark grey quartzites, succeeded at the eastern point of this indentation by chloritic and feldspathic schists, but further eastward along this shore, in the rear of Crow Harbor, there are, beneath the schists, which here contain a few thin limestone bands, heavy masses of grey felsites. These strata are separated from those of the first named belt by the rocks of the Kingston group.

Third tract. The third tract extends from near the eastern shore of Mace's Bay, in Charlotte County, across the peninsula terminating at Point Lepreau, and comes out on the coast again in St. John County, occupying on the shore, the space between Little Musquash Harbor and Dipper Harbor. In this area the rocks are chiefly red argillites, conglomerates, grey sandstones, and grey felsites. The felsites are overlaid at one or two points by schistose beds with limestones, corresponding in position to the schists, etc. forming the coast between Beaver Harbor and Lepreau Harbor.

Fourth tract. Still another tract of these rocks extends from Cape Spencer eastwardly along the coast of St. John County to Shepody Mountain, in Albert County. Here the lowest beds are red conglomerates, argillites, and quartzites. At Black River they rest upon the Dadoxylon sandstone. The red beds are overlaid by grey clay-slates, enclosing a few limestone bands. To these, succeeds a great mass of grey chloritic grits and micaceous schists, surmounted by greenish and red argillites, and diorite. At Little Salmon River, near the eastern end of this tract, there is a synclinal fold in which are chloritic schists, grey argillites, and nacreous slates, capped by red and purple argillites, and silicious felsite or jaspery petrosilex.

Grand Manan. On the island of Grand Manan, near the entrance of the Bay of Fundy, and among the smaller islands which skirt its southern shore, a series is exposed, comprising micaceous and chloritic schists of white, green and

purple colors, grey quartzites and granitoid grits, with some limestones, which bear much resemblance to the Coastal group.

The strata referred to this group in the interior consist, like those of the coast, of red slates and conglomerates, felsites of pale red and grey colors, grey chloritic schists, granitoid grits, etc. They form a narrow belt skirting portions of the northern shore of the Long Reach of the St. John River, and the depression of Belleisle Bay. Interior belt.

The various rocks which make up this Coastal group will be made the subject of further remark in the following more detailed descriptions of the several tracts in which they occur.

Details of the Coastal Group.

1. Beaver Harbor, L'Etang, and the Western Isles.—Both sides of Beaver Harbor, near its mouth, are formed by the belt of Kingston rocks, which here reaches the coast from the interior, but on the northern side of these, crossing the head of the harbor, strata of the Coastal type appear, emerging from beneath the large plateau of quaternary gravel called Pennfield Ridge, and extend thence towards the eastern shore of L'Etang Harbor, near its entrance. A little to the north and west of the town-plat of Pennfield, and along the road leading to the latter, these Coastal rocks are somewhat coarsely granitoid, being mostly of a pinkish-grey, sometimes of a purple color, containing much pale red, light-weathering feldspar and quartz, with a considerable admixture of a pale green mineral (chlorite?) and sometimes a little hornblende. In the same beds are lodes of quartz, containing sulphurets of copper and lead. With these coarser rocks there are also purplish-grey felsites containing grains of quartz, and beds of diorite. At the settlement in Beaver Harbor the rocks are more schistose, exhibiting alternations of hard and compact with finely bedded feldspathic strata of a greenish-grey color, followed by dark grey fissile beds, both nearly vertical. These latter are a portion of a belt consisting mostly of dark grey and black slates filled with iron pyrites, which extends from Beaver Harbor nearly to Deadman's Head. They are well exposed in Wright's Head, just below the settlement above alluded to on the western side of the harbor. In their deep black color and highly carbonaceous nature they resemble the shales of the St. John group seen at Black Beach in Musquash Harbor. They differ, however, from them in having more numerous, but thin and very regular seams of grey and dark grey quartzite. South of Wright's Head a mass of olive-grey feldspathic slates may be seen to intervene between these black slates and the dioritic strata of the Kingston group. These two masses of strata, viz., the black slates of the head, and the olivaceous beds south of it, are vertical. They extend westward as far as a long narrow peninsula, which, terminating in Deadman's Head, separates Deadman's Harbor from the open bay. This, to the northward of the black slates, is

Beaver Island.

Pennfield.

Black Slates.

Wright's Head.

Deadman's Head.

chiefly composed of hard purplish quartzite or quartzose felsite, with beds of green and purple slate, resting upon hard grey sandstone, and having but a moderate dip (about 30°) to the northward. On the seaward side is a mass of dioritic trap, which appears to be intrusive.

Deadman's Harbor.

The northern shore of Deadman's Harbor is composed of pale olive-green slate and conglomerate, but between these and Black's Harbor a mass of felsites intervenes, separating these green strata from thick beds of red conglomerates, with thinner beds of sandstone, dipping N. 80° W. < 30°. These conglomerates abound with large angular blocks of gray granite, a rock which we have nowhere seen *in situ*, near here. Similar conglomerates, brought up to the northward of these by a fault, form the peninsula terminating in L'Etang Head, with the same dip of 30°, and re-appear in Bliss's Island, and in the smaller islands (Governor's, Bar, Fox, Flea, and Man-of-War Islands), which lie between the latter and Frye's Island. On the north side of the ridge terminating in the head referred to, and opposite to the upper end of L'Etang Peninsula, these coarse conglomerates are succeeded, after a space filled with clay, by slaty grits with a grey chloritic paste, and grey argillites. With these is connected a body of slaty conglomerates with a paste similar to that of the grits, having a dip (or cleavage) S. 20° E. < 60°. Here there appears to be an anticlinal fold, and similar beds with a ferruginous trap-like rock holding slate pebbles (dip or cleavage N. 40° W. < 60°). Beyond, in a northerly direction, there is a greenish-grey chloritic grit, with some diorite and conglomerate layers, which appear to be reversed in a dip along the river. From this hill of grey chloritic rocks, which makes a little peninsula jutting out into the inner harbor of L'Etang, to the head of a long straight reach extending about half way up L'Etang River, the whole south shore, as far as we were able to examine it, was found to consist of similar rocks.

L'Etang.

Bliss's Island.

On Bliss's Island there is an anticlinal fold in the red conglomerates first referred to, the dip being 40° south-westerly on the southern, but N. 60° W. < 20° on the northern side (near the western end of Pentelow's Cove), and a similar irregularity occurs in the case of the smaller islands above named. On some of these (Flea Island, etc.,) the coarse sediments are associated with and contain fragments of amygdaloid, together with those of granite, granulite, slate, etc. These conglomerates are older than those of the Perry group, for though soft and but little altered, the sandy layers have a very distinct slaty cleavage, intersecting the bedding at a high angle. Of nearly the same age, but somewhat different in aspect, are the beds which form a part of the northern side of Bliss's or L'Etang Harbor, and appear on Frye's (Cailiff) Island and the adjoining islets. These are softer, and may not be of the Coastal group, but there can be little doubt that they are, at least, as old as the Devonian, for slaty cleavage, so common in the finer beds of the Pre-carboniferous rocks in Southern New Brunswick, is strongly marked in these.

Frye's Island.

A depression filled with clay, and nearly cut through by the tide, connects L'Etang peninsula with the mainland, and marks the separation of the Mascarene Lower Kingston slates from the felsites and chloritic rocks which, as we suppose, here form the upper part of the Coastal group. In going southward from this neck of land, the first beds seen—on the south side of a cove which puts in from Inner L'Etang Harbor (or L'Etang River)—on the east side of the peninsula, are chloritic beds with a dip or cleavage of N. 30° W. <70°. At the next little cove, purple-red sandy slates, followed by grey chloritic rock, with a dip (or cleavage) N. 30° W. <50°, may be seen. Beyond this, purplish-grey conglomerates, with pebbles of felsite, cross the road leading out upon the peninsula. For more than a quarter of a mile beyond this, until it reaches a point where the peninsula is again nearly intersected by coves, the road crosses ledges of grit having a paste of greenish-grey chlorite, and slate. Here follow exposures of hard grey clay-slate, resembling the Mascarene slates in texture, and having a dip S. <70°. L'Etang river.

Just across a hollow at the head of Western Cove fine grained diorites appear, flanked on either side by finely laminated pale grey clay-slates, which are sometimes calcareous. Beyond these beds, and continuous with them, are pyritiferous quartzites, the latter sometimes graduating into clay-slates, the dip near the road being S. 10° W. <60°, but a little to the eastward S. 30° W. <60°. These rocks, with the succeeding calcareous beds, resemble the quartzite and limestone series of the Laurentian area in St. John County. Passing around the south shore of the little cove referred to, alternations of these grey clay-slates and slaty limestones in thin bands may be seen, having a dip S. <70°. Advancing southward to the lime-quarries, slates give place entirely to grey and dark grey limestones. These limestones are intersected by dykes of intrusive rock, having sometimes a columnar structure. One variety is peculiar, having the aspect of an argillite or pale grey clay-slate, studded with cubes of iron pyrites. Beyond the quarries there are slaty limestones again, tinted pale green and red in narrow alternating bands (dip S. 30° W. <70°). These are surmounted by greyish-white, pale buff-weathering dolomites, which break into angular fragments (dip S. 30° W. <60°.) At the top they include striped layers. Limestones & quartzites. Dolomites

A little cove and beach separate these limestones and dolomites from purplish and green chloritic slates very like those at the summit of the Coastal group. To these succeed, across a small beach, a mass of reddish feldspathic grit, with beds of greenish slaty conglomerate, dolomite (?) and slate, containing spathic iron. On the south side of a fault the same beds are repeated with a high southerly dip (<80°). Passing around the extreme point of the peninsula, they were seen again at Man-of-War Cove, and are underlaid by thin beds of impure grey limestones. Further up the L'Etang River, the limestones seen at the quarries come out upon the shore, and beyond them the quartzites and associated pale grey slates, here in larger volume

than where first seen on the west side. They form the easternmost point of the peninsula; and beyond them to the northward lie grey chloritic rocks like those alluded to above, which come to view in several small islands in the inner harbor of L'Etang, and again on its eastern shore, as before related.

Frye's Island. The general structure of L'Etang peninsula is repeated in Cailiff (or Frye's) Island, with which it is connected at low water by a bar. The first rocks seen on entering the island at its north-east corner are purple conglomerates, green slates and diorites, with greenish-grey grits or conglomerates, to which succeed the grey chloritic rocks seen on L'Etang peninsula. Granitoid rocks. These are imperfectly schistose, of a somewhat granitoid aspect, but frequently enclosing masses of different shades of color, as if the whole had once been in the condition of a coarse sandstone or conglomerate. Much of this rock consists of grains of quartz, more or less rounded, buried in a paste of grey or apple-green color, consisting of feldspar and an apparently chloritic mineral. These rocks are probably of great thickness, since on the eastern side of the island they have a surface breadth of half a mile. The cleavage planes by which they are intersected give them the appearance of vertical beds, lying between the perpendicular Kingston slates of Back Bay on the north-west, and the limestones already described on the south-west. We have not yet met with similar rocks holding this position in the Upper Silurian series, and therefore incline to believe that they are a portion of the Coastal group. At Birch Cove Limestones. they give place to a thick belt of crystalline limestones, similar to those of L'Etang peninsula, with which they are connected by a chain of small islands across the intermediate sheet of water. Their strike is W.S.W., in which direction they extend to Mill Cove, on the western side of the island, but near the head of the latter are cut off and abut against a series of fine grained slates, filled with ferruginous specks, which form the northern shore of the same indentation. On the southern side these slates may be seen at the water's edge, but here they rest upon another lenticular mass of limestones, of which about one half are magnesian, while the remainder, like those of Birch Cove, are of the ordinary variety. To the south of these limestones,—which Serpentine. are associated with a pale yellowish-green massive idoerase, and which we think may be a part of the older mica-schist and limestone series, which, at St. John, overlies the coarsely crystalline Laurentian rocks (see page 31), —lie a thick series of dark dioritic rocks, partly schistose, which with felsites and reddish granitoid rock, rise into a prominent ridge. These hard rocks are succeeded by softer Upper Silurian shales.

In concluding our description of the Coastal group in this district, we give here a series of notes, taken among the smaller islands which lie to the westward of L'Etang, and southward of Deer Island, forming with Western Isles. the latter the chain of the Western Isles, upon several of which sediments of the Coastal type have been recognized. Of the thirty or more small islands which are included in this chain, we have been able to examine a portion only

The strong tidal currents, which here prevail, render them somewhat difficult of access, but sufficient has been seen to show the general range of the formations in the chain.

As a whole, these formations may be regarded as a continuation of those already noticed about L'Etang Harbor, but, like the latter, may include Upper Silurian as well as Coastal rocks, with the addition perhaps, at some points, of those of the Perry group. As these are not in all cases easily distinguishable, they are considered together in the following descriptions of the islands examined.

The most easterly island of the chain is Adam's Island, which is interesting both for its peculiar geological features and the valuable mineral deposits which it holds. In traversing this island across the course of the beds, the following succession was observed:— Adam's Island

a. Hard grey dioritic rock in massive beds, alternating with amygdaloidal diorite, the latter filled with seams and blotches of calc-spar and holding pebbles of blood-red jasper. Section.

b. Dark grey breccia, composed of angular fragments of diorite, from two inches to a foot or more in diameter, cemented by calc-spar.

c. Beds similar to those of *a*.

d. Hard and coarse purple conglomerates, dipping N. 60° W. < 50°, holding pebbles of purple slate and grey felsite. This passes into a purplish-red sandstone, which is again followed by red sandstone and conglomerate, with the same dip as above.

e. Greenish-grey shales, enclosing lenticular beds of pink white-weathering conglomerate, made up almost wholly of pink jaspery felsite. The shales farther south become coarser and alternate with conglomerates of the same color. These, with compact greenish-grey epidotic rock, form the southern shore of the island.

Mining operations have been for some years in progress on this island, and about twenty-five men were in employment at the time of our visit. The ore is erubescite or variegated copper ore, which has been raised in considerable quantity from a shaft sunk in grey amygdaloidal and compact greenish-grey epidotic diorites, similar to those at the beginning of the above section. The ore is mostly confined to the vein, which is a true lode cutting the strata, and consists of quartz and calc spar. Small strings of it are also found in the adjoining amygdaloidal diorites. Near the shaft the latter overlie a red conglomerate, having a dip S. < 70°. Copper ores.

We have not elsewhere seen rocks resembling in all respects those of Adam's Island, but their general aspect is that of the Coastal group. A little to the south-west of Adam's Island lies Simpson's Island, where ores of copper have also been met with. Upon this we have not landed, but as it is in the direct course of the Adam's Island rocks, and the interval between the two is small, it will probably be found to present the same features. Simpson's Island.

Several small islands lie to the east and south of the last two named. On one of these (Nubble Island?) the southern shore was found to present Nubble Island

steep bluffs of red slaty conglomerate, together with a grey porphyritic rock, having a reddish-grey feldspathic base with scattered crystals of red feldspar. The dip is S. 10° E. < 60°, but irregular, the rock being much broken, and the lines of fracture occupied by epidotic veins from two to three feet in thickness. Some portions are amygdaloidal. Not far removed from this

White Island. island, but quite dissimilar in character, is White Island. This, so far as examined, was found to consist of coarse red and grey conglomerates, holding granitic boulders, and alternating with thin beds of red sandstone. These are similar to the conglomerates already noticed on Bliss's Island, near L'Etang, and have, on the southwest side of White Island, a dip N. 30° W. < 40°.

Southwest of White Island, two islands, somewhat larger than the last, intervene between this and the entrance of Head Harbor Passage. Of these

Spruce and Sandy Islands. the more easterly, named Spruce Island, is composed of red conglomerates, like those last described; the other, Sandy Island, is composed of rocks more nearly resembling the ordinary Coastal type. These consist of pale reddish-grey jaspery felsites, and pale greenish-grey and pink granitoid grits. The stratification of the latter is obscure, but they are probably recomposed rocks, exhibiting in some portions the aspect of a conglomerate, and containing at some points small imbedded masses of red felsite, which resemble pebbles.

Casco Island. Similar rocks are also seen on Casco Island, which lies to the southwest of, but in the same general line with White and Spruce Islands, and exhibit the same variations in color and texture, some portions being fine grained and homogeneous, while others are quartzose and coarsely granitoid. These rocks form the northwest side of the island, where their dip, which is somewhat irregular, appears to be about N. 70° W. < 60°. In direct contact with them, in a cove on the southern side of the island, are coarse brownish-red conglomerates, holding pebbles of red shale, grey granitoid rock, diorite, and red felsite. The line of division between the two is nearly vertical, the conglomerates being slightly overlapped by the granitoid rocks. The age of these conglomerates is uncertain, but their composition is such as to show that they are more recent than the rocks with which they are in contact. In descending upon the beds, which dip uniformly W. < 70°, these are found to become coarser and to be largely made up of pebbles of granitoid rock, similar to those which form the northern side of the island. Their general position is that of the conglomerates already noticed in White and Spruce Islands.

Three small islands intervene between Casco Island and Indian Island.

Green Island. On Green Island, which is the first of these, the rocks are pale reddish-grey fine grained granitoid rocks, with hard grey shales, in beds which are much disturbed and corrugated, but which have a general course similar to those of Casco Island, of which they are probably the continuation. On Harris's

Folly Island. or Folly Island (also called Pope's Folly), the rocks are somewhat different, and appear to comprise portions of two series which are unconformable. Of

these the upper and more recent occupies the central portion of the island, and is well exposed on its eastern side, consisting of hard fine grained sandstones and sandy slates, the general color of which is grey, but which exhibit throughout a banding of lighter and darker shades. These are very conspicuous, and on weathered surfaces are seen to correspond to layers of unequal hardness. This rock is slightly calcareous, and contains much carbonate of iron, in consequence of which it weathers to a rusty brown, and is in some parts thickly covered with yellow ochre. The dip of these strata is N. 30° W. < 60°. Towards the northern end of the island the dip becomes irregular, and the beds are folded. They are then cut off by a fault, and abut against heavy beds of compact light colored felsites, which form the remainder of the island in this direction. Similar beds also appear at its south-west end. They are cut by several vertical dykes of diorite, and in some parts hold pebbles, becoming a grey conglomerate.

Thumb-cap Island.

The Thumb-cap, a small island lying a little to the south and west of Folly Island, is composed of coarse brownish red conglomerates, probably the same as those of White, Spruce, and Casco Islands. A similar rock forms Cherry Island, just to the east of Indian Island. The latter we have not examined.

Cherry Island.

The chain of islands above described, from Adam's Island to Indian Island, is in the same general course with that of Frye's Island and L'Etang, to portions of the strata of which they also bear much resemblance. To the northward of this belt, and between it and Deer Island, are several smaller islands, which in position correspond more nearly with those of Back Bay and La Tete. On Bean's Island, which lies nearly midway between the southern end of Simpson's Island and the shore of Deer Island, near Lord's Cove, are heavy beds of pale pinkish-grey cherty felsite, interstratified with and passing into greenish-grey thin bedded, soft and somewhat unctuous crystalline schists, which are also chloritic and epidotic. The dip of these strata is N. 50° W. < 90°. Somewhat similar rocks form Hardwood Island, to the east of the last, as well as portions of the shore of Deer Island. It is not, however, certain how many of these belong to the Coastal, and how many to the Kingston group. They will be more particularly considered in connection with the latter.

Bean's Island.

Felsites and crystalline schists.

Hardwood Island.

Between Beaver Harbor and New River, the Kingston and Coastal groups are both concealed from view by extensive deposits of Post-pliocene sand and clay, forming Pennfield Ridge and New River plains. On New River however, about two and a-half miles north of the post-road, a body of slates, resembling those of the Coastal type of Huronian, crosses the stream. They are exposed in bare ledges about the mouth of the north-east branch. On the south side of this stream, there are grey argillites and dark purplish fine grained feldspathic conglomerates, holding flattened pieces of purplish-red and grey slate, and speckled with grains of quartz. They dip S. 10° E. < 70°.

New River.

On the north side of the same stream there are also reddish felsites, with a conglomerate similar to that on the south side, and having various dips (N. $<$ 30° ; S. $<$ 50°, and S. 80° W. $<$ 70°). One half mile further up the main stream, there is a purplish sandy fine grained conglomerate, with slate pebbles, in vertical beds, of which the course is N. 40° E., passing into fine dark grey and purplish-black thin bedded fine grained feldspathic rocks. For two miles beyond this no exposures were observed along the stream, the rocks being covered by sandy loam. At Crooked Falls, five miles from the post road, ledges of red granitoid rock cross the stream. These resemble certain granitoid grits occurring in connection with rocks of the Coastal group to be presently described, on the Nerepis River, but are more crystalline. Just beyond them, extending to a little brook which enters the river on the west, are hard dark grey compact fine grained feldspathic beds of Huronian aspect. One mile further up are dark grey fine grained schistose rocks, with specks of kaolinized feldspar, and grey petrosilicious beds, and further on, fine grained dioritic beds. After traversing another two miles without rock exposures, ledges of the banded grey petrosilicious rocks seen at Lake Utopia and elsewhere about Passamaquoddy Bay, appear, dipping S. 20° E. $<$ 60°. This point is one-eighth of a mile south of the base of Porcupine Mountain, a high ridge of intrusive syenite connected with the Nerepis granite. A ridge of granitoid rock, similar to that on Crooked Falls, lies nearly midway between New and L'Etang Rivers. It crosses the post-road, and passes beneath the gravel ridges of Pennfield.

Porcupine Mountain.

West Musquash River.

In examining the West Musquash River, no schistose rocks referable to the Coastal group were observed; but certain granitoid beds on this stream, south of the red Nerepis granites, and between them and the Kingston group, correspond in position to the strata which come out upon the Bay of Fundy, at L'Etang Harbor. These occur at the mouth of Seven-mile Lake Brook. On this stream there are ledges of feldspar rock, and of dark granite or gneiss, together with a red granite or granitoid grit, having no mica, and near by, ledges of porphyritic felsite. These resemble somewhat the strata seen near the Roman Catholic chapel in Lancaster (see page 94). A little higher up the river, at the Round Dam, are ledges of a variety of granite, with dark green feldspar.

From Beaver Harbor to Lepreau Harbor.

Negro Harbor.

The rocks of the Coastal group which appear at the head of Beaver Harbor are on the eastern side of this haven separated from the rocks of the same group which stretch along the shore from Negro Harbor, by the belt of Kingston rocks which here reaches the coast from the interior. At Negro Harbor the rocks, as already described, are dark grey quartzites, overlaid by chloritic

and feldspathic schists. To the eastward of this harbor, the shore is much broken by numerous headlands and indentations. Upon some of these the rocks are those of the Coastal group, while others, in their highly crystalline character and general aspect, recall the more ancient sediments of the Laurentian system. Beds of this latter class form the shore just west of Seely's Head. They consist of greenish and reddish syenitic rocks, which are somewhat epidotic, and are cut by pyritiferous dykes, holding copper pyrites. To the eastward of these are greenish-grey chloritic schists, forming the western side of Seely's Cove. Along the road which connects this cove with Seely's Creek, the rocks are mostly granitoid and highly feldspathic, of greenish-grey colors, weathering from pale grey to white. On the east side of Seely's Creek are similar rocks, but containing finer grained and more schistose beds, some of which are silicious and others a pale grey felsite. They are cut by veins of quartz containing small quantities of copper ore, and dip N. 40° W. < 90°. A small headland separates the indentation receiving the waters of Seely's Creek from that of Crow Harbor. On this point, about half-a-mile west of Crow Harbor Island, a quartz lode, about two feet wide and containing considerable quantities of copper pyrites, in pale reddish-grey and greenish-grey granitoid grits was observed, The latter consist of quartz with much feldspar and a soft green mineral resembling chlorite. In the rear of this harbor these feldspathic and chloritic schists are underlaid by heavy masses of grey felsite. These schists form the shores of Red Head Harbor, and thence extending across the long promontory terminating in Red Head, reappear in Pocologan Harbor, and along the coast eastward of Pocologan River. The promontory of Red Head consists chiefly of a compact granitic rock, having much pale red feldspar and little or no mica.

Seely's Head & Creek.

Crow Harbor.

Copper ore.

Red Head.

At several points along the shore in this neighborhood, the rocks have been found to contain the sulphurets of copper. One of these points is at McLean's Mills on Locke's Brook, where small quantities of copper pyrites occur in quartz veins penetrating greenish-grey somewhat unctuous chloritic slates, dipping S. 10° E. < 50°. The stream last named is not far from the mouth of New River. In the cove between the latter and Barnaby's Head are low bluffs of fine grained greenish-grey granitoid rock, filled with veins and irregular masses of coarse bright red granite, varying from one inch to six or eight feet in diameter, the whole mass being much broken and filled with epidotic matter. A long peninsula terminating in Barnaby's Head separates this cove from Fielding's Cove and Lepreau Harbor. We have not examined the whole of this peninsula, but where it is connected with the mainland, near Fielding's Cove, the rocks are red somewhat schistose granitoid strata which may be of Laurentian age. With these are fine bedded grey chloritic schists and chloritic gneiss, and around the shores of the last named indentation, which forms the western side of Lepreau Harbor, similar beds with highly feldspathic light-weathering granitoid grits. These light colored, im-

Barnaby's Head.

Lepreau Harbor.

perfectly crystalline and schistose rocks, probably belong to the Coastal group; but may be a part of the Kingston group of the Huronian series.

Coastal Group in Western St. John County.

Ridges of Laurentian granitic gneiss, described in previous pages as extending from Musquash River to Lepreau Harbor, separate the Coastal rocks last described from those which skirt the coast of St. John County between Mace's Bay and Musquash Harbor. On the southern side of the ridges in question, the rocks, which appear from lithological characters to belong to the Coastal group, are everywhere separated from the crystalline belt by a series of soft grey sandstones and shales, resembling those of the Dadoxylon sandstone of the vicinity of St. John, and like this containing, at Lepreau Harbor, remains of Devonian vegetation. These Devonian sediments appear to dip beneath those of the Coastal type at those points where the two have been observed together, but, as the latter are lithologically unlike those of the Devonian series, and do strongly resemble those elsewhere referred to the Coastal group, we suppose that the appearance alluded to is due to a dislocation.

Relations of Devonian & Coastal rocks.

Lancaster.

This view receives confirmation from the fact that in the village of Lancaster, on the northern side of the belt of Devonian sediments, the Dadoxylon sandstones may be seen to rest upon a series of strata very nearly resembling the belt of Huronian rocks nearer the coast, but here in a reversed order, being apparently overturned against the Laurentian gneiss, upon which they rest.

The most complete succession in this group of beds is to be seen on the hill in the rear of the Roman Catholic chapel, near the house of P. Byrne, in the village of Lancaster. Ledges of Dadoxylon sandstone here stand out from beneath the soil of the hill-side which overlooks Knight's mill-pond. Higher up on the hill, and beneath the sandstone, masses of coarse reddish-grey conglomerate, with beds of deep red slate appear. The same rocks, a mile or so to the eastward, form the eminence known as Diamond Hill. In the rear of these bright red rocks, on the hill first mentioned, there is the following succession going northward:—

Succession in Lancaster.

Pale brown sandstone, with dark red argillite.
Reddish breccia-conglomerate, enclosed between beds of dark red argillite.
Pale red and grey variegated limestone in beds of small thickness.
Pale red felsites, sometimes dotted with grains of quartz.
Dark colored granitoid rock, apparently a grit composed of the debris of granite.
Granitic rock, consisting of red feldspar, pale green chlorite and quartz.

Northward of these the Laurentian gneiss occupies a belt of country several miles wide.

The strata which appear to be the equivalents of the above series, are best seen along the road leading from the St. Andrew's post-road, about two

miles west of the village of Lancaster, to the coast at Dipper Harbor. For nearly half-a-mile southward of the junction of these roads, ledges of grey Dadoxylon sandstone, with some beds of conglomerate, cross the road, apparently dipping S. 30° E. < 60°. These are followed on the south, after a short interval, by purplish-red argillites and conglomerates. Where first seen, these have a dip S. 60° E. < 50°, which, within a short distance, changes to S. 10° E. < 70°, then to south, and finally, about a mile from the first exposure, becomes reversed (N. 80° E.), indicating a synclinal. These are followed and apparently overlaid by beds of dark reddish-grey petrosilex or felsite, passing into amygdaloidal diorites. These rocks, with some dark colored and fine grained feldspathic beds, appear along the eastern side of the road at and below the point where the Dipper Harbor road diverges from that leading to Chance Harbor. The felsites are at some points porphyritic with small crystals of red feldspar, and contain shot-like quartz grains. They are intersected by numerous quartz veins, dipping S. 20° E. < 30°. From this point, along the first named road, to its junction with that leading to Lepreau Basin, are low ledges of somewhat slaty felsite-porphyry, separated by intervals in which appear beds of purple-red slaty conglomerate, apparently conformable to the former, and dipping beneath them. With these beds are also bluish and grey sandstones, containing small crystals of red feldspar, and numerous small black specks which resemble crystals of augite, together with thin beds of bluish-grey, greenish and reddish shales. The dip of these beds varies from S. < 70° to S. 10° E. and S. 10° W. < 30°. For one and a quarter miles beyond the forks last alluded to, the ledges by the road side are mostly of felsite-porphyry, of variegated colors, and associated with thinner beds of fine grained dark grey diorite. The dip in this distance becomes reversed from S. 30° W. < 30° to N.W. < 40°—50°, and again to S.E. < 30°. In approaching Dipper Harbor, the slaty felsites, dipping S. 20° E. < 50°, are associated with purple argillites. The northern shore of this indentation is composed of the felsites in question, and no higher beds are here seen, the opposite side of the haven being covered with Carboniferous conglomerates ; but at a point about midway between this harbor and the eastern shore of Mace's Bay, thin deposits of blue limestone were observed, overlaid by buff slate and dipping westerly. These strata are connected with the older series noticed above.

Dipper Harbor road.

Felsites and petrosilex.

Felsite porphtry.

Dipper Harbor

To the westward of the Dipper Harbor road the rocks are much obscured by woods and surface-deposits, and their relations at the same time complicated by numerous folds and faults. Near Lepreau Basin red and purplish argillites, similar to those first noticed on the road to Dipper Harbor, come into view, and are associated with a thick series of grey sandstones and dark grey shales, not distinguishable from those of the Dadoxylon sandstone, and at one point (at the head of Lepreau Basin), rest in nearly horizontal beds upon grey shales, containing obscure remains of plants. To

Lepreau Basin

the northward of this indentation they occupy much of the peninsula separating the latter from Little Lepreau River, being flanked on either side by the grey sandstones above mentioned. Their dip is quite irregular; at Downing's Brook it is S. 10° W $<$ 70°, while a short distance eastward, they fold over and dip N. 20 E. $<$ 20°. Near the centre of the basin thus formed, the red arenaceous and shaly beds are covered by red and grey variegated limestones, dipping N. $<$ 40°. These are in appearance the same with the limestones in the rear of the village of Lancaster, already noticed. The red and purplish argillites which appear near the head of Lepreau Basin, are again exposed along the southern side of this depression, where they have a surface breadth of over one thousand feet, the dip being N. $<$ 80°, declining to N. $<$ 50°. Near the ferry, at the mouth of the basin, are fine bedded red conglomerates, holding pebbles of red and white limestone, and red slaty sandstones, dipping S. $<$ 90°. A little south of the above, but separated by a small cove, are greenish and reddish felsites. This point is about three-fourths of a mile northward of the limestone beds, noticed above as occurring nearly midway between Dipper Harbor and Mace's Bay. A small island near the entrance of Little Lepreau Harbor is composed of limestones, probably of the same age as those noticed to the eastward of this indentation, and in the village of Lancaster.

Limestones.

A ridge of Laurentian granitic gneiss which crosses the Narrows at the mouth of the Musquash River, separates this belt of Devonian and associated strata from a second and smaller one wedged in between this ridge and the Laurentian chloritic gneiss which crosses Musquash Harbor. The beds seen in this trough, near the Narrows, which are not unlike Devonian sediments, are the following:—

Musquash.

Reddish-grey conglomerates and purplish-red argillites, partly overturned, but mostly perpendicular or dipping at a high angle to the south and west. These are succeeded by

Grey sandstones, also dipping alternately south and west, at angles of 60° or 70°.

Greenish-grey argillites, reddish-grey conglomerates and purplish-red argillites, dipping like the sandstones. Here the beds are much crumpled and contain stems of plants. This is the north-east corner of the basin. Further to the southwest appear

Dark grey argillites, probably a part of the same series.

Similar red and green strata are wedged in between these mica-granite and chlorite-granite ridges at their western end. Thus, just eastward of Harbor-by-Chance is a valley extending north east between these ridges of older rock, in which lie beds of red conglomerate and argillite, dipping S. 50 E. $<$ 60°, and resting upon dark grey granite, to the north of which are granites with pink and green feldspar. These red conglomerates are succeeded by grey sandstones, dipping S. 40° E. $<$ 60°, which in turn are covered by red slaty conglomerate and dark green dioritic schistose beds. The above named strata mantle around the granite on the east side of Harbor-

Harbor-by-Chance.

by-Chance, where dark red argillites and conglomerates appear. On the west they lie in two low undulations, exposing chiefly the three members above noted, and extend onward with much the same features to Chance Harbor, on the east side of which they are covered by a grey chloritic schistose rock. Opposite Boyle's, on the west side of the harbor, is a dome of the grey sandstone above noted, resting upon the red conglomerate and covered by red argillite and hard greenish-grey sandstone or chloritic rock, visible on the opposite side of the harbor. Chance Harbor.

Much of the area intervening between Musquash Harbor and River and Pisarinco Harbor is occupied by crystalline rocks of the Laurentian system, and the calcareous and quartzose strata connected with them, but at several points these are covered by small outlying patches of more recent origin, which nearly resemble those described above near the first named harbor. The rocks in question consist of coarse bright red and very quartzose conglomerates, associated with bright red sandstones, and may be seen at intervals along the post-road eastward of Musquash Settlement, and particularly in the depression of Spruce Lake, at the outlet of which they rest unconformably upon the Laurentian gneiss, with a dip S. 30° E. < 80°. These are probably of the same age as the red sediments beneath the Dadoxylon sandstone in the village of Lancaster. Spruce Lake.

Between the same two harbors, but nearer the coast, is another belt of strata which probably pertain to the Coldbrook group. These lie to the southward of the belt of limestones, etc., connected with the Laurentian series already described as crossing the southern part of the peninsula of Pisarinco, and extending along the shore from the settlement of Irishtown to Negro Head. Near the latter they include the following members: Irishtown.

Greenish-grey argillites, in part micaceous, and holding specular iron. Dip S. < 40°.
Greenish-grey arenaceous slate.
Dark grey, pale grey-weathering argillites.
Reddish feldspathic slates.

As seen from the sea, the colors peculiar to the rocks of different ages along the coast from St. John to Lepreau are clearly distinguishable. Thus, the pale green tint of the Huronian series may be seen in the rocks from Negro Head (Pisarinco) to Gooseberry Islands, half way between Musquash and Little Musquash Harbors; a pink tint marks the Laurentian chloritic gneiss from the same point to midway between Little Musquash Harbor and Harbor-by-Chance; dark red is then the prevailing color as far as Chance Harbor, where the strata in the sea-cliffs are of the Coastal type of Huronian strata; palé grey and white-weathering felsites of the same group then occupy the shore as far as Dipper-Harbor, whence to Point Lepreau extend brownish-red conglomerates and bright red sandstones of the Perry group of the Devonian series. Aspect of groups from the sea.

Costal Group in Eastern St. John and Albert Counties.

The rocks of the Coastal type in the fourth and last of the areas alluded to in preceding pages as occurring near the Bay of Fundy, have been described as extending from Cape Spencer in St. John County to Shepody Mountain in the county of Albert. On account of the position of these strata relative to the Dadoxylon sandstone, as well as their lithological resemblance to the more schistose portion of the Cordaite shales and flags in the adjoining Mispec Barrens, this metamorphic series was described in our report to the legislature of New Brunswick in connection with the Devonian rocks, under the head of the Coast series. Dr. Gesner had previously grouped them with the Devonian rocks of Mispec Barrens and Harbor, under the designation of "primary schistose rocks." Their superposition on the Dadoxylon sandstone, however, being probably the result of a fault and overlap, they are considered as pertaining to the same horizon with the strata already described along the coast westward of St. John, and in Charlotte County, to which the designation of the Coastal group has been given.

History of Coastal group.

The strata of this group are well exposed in the vicinity of West Beach and Black River. At the former place they present the following succession, in which a part of the same series may be repeated by faults :—

Succession of West Beach.

1. Red clay-slate and grit and coarse reddish micaceous sandstone, resting upon the Dadoxylon sandstone.
2. A thick mass of granitoid grit, with beds of dioritic rock.
3. Grey micaceous slate.
4. Reddish-grey sandstone and grit, overlaid by coarse conglomerate holding beds of jaspery hematite.
5. Dark grey micaceous slate and diorite.

Black River

At Black River the granitoid beds are more schistose, and have many intercalated feldspathic and dioritic beds. In the upper part they hold several large beds of specular hematite. On the eastern side of Black River there are, along the shore, argillo-micaceous slates above the schistose grey strata, near which are exposed much softer argillites of green and purplish colors, associated with beds of fine grained dark grey diorite.

Nearly a mile east from Black River, at the base of the granitoid schist above described, are grey clay-slates, which appear to be on the line of a minor synclinal fold. These beds hold imperfect remains of plants, and are tinged of a green color by the decomposition of copper pyrites. There are impure grey limestones, containing copper-glance and pyrites, associated with these slates. Beneath these slates and limestones, along the Mountain road to Loch Lomond, heavy beds of coarse reddish-grey conglomerate may be seen These are the same with the beds of conglomerate and red sandstone so well exposed on Black River above the bridge near the mills at the mouth of the stream. At the latter locality the red rocks

Copper ores.

may be seen to rest upon Dadoxylon sandstones, which appear in broad ledges at the mouth of the east branch, and hold trunks of trees and other remains of ancient vegetation.

Eastward of Emerson's Creek, this Coastal group of strata is covered by sandstones and shales of the Carboniferous system, as far as the eastern end of Quaco Settlement. The high and broken country along the coast east of the plain of New Red sandstone and Carboniferous rocks at Quaco has not been explored, but, according to Dr. Gesner, rocks similar to those of West Beach traverse it. Some scattered observations were made by us in these hills (more especially in that part extending from Little Salmon River eastward to Shepody Mountain), in 1864. We are unable to distinguish the Coldbrook from the Coastal strata in this region, but from the nature of the rocks exposed along the Little Salmon River, suppose that the former group occupies a large area here. The following observations on the last named stream, beginning at a bridge about eight miles above its mouth, are taken from our Report of 1865 to the legislature of New Brunswick. "At the bridge, and for a mile below it, the bed of the stream is filled with shingle and boulders, though ledges of slate of pale buff, grey, reddish, purplish, and greenish colors appear at intervals, apparently talcose, but in reality micaceous. Below the bridge, for the first two miles, the valley is narrow, and shut in by lofty and steep hills from one hundred and fifty to two hundred feet high. The rocks which appear along the sides of the stream are chiefly schistose, becoming coarser in texture as the Upper falls are approached. Near the falls, beds of greenstone may be seen interstratified with bluish and grey slaty micaceous grits. At this point the depression through which the river runs is no longer a valley, but becomes a narrow gorge or ravine, shut in by precipitous hills, increasing in elevation as the coast is approached, from two hundred and fifty to four hundred feet high. One elevation, opposite Carleton's mill, is said to rise to the height of five hundred feet. For six miles the bottom of the gorge is very rough, and the stream is broken by frequent falls, rapids, and eddies. So tortuous does it become, that in many places the bed of the stream and the course of the valley cannot be seen for a distance of more than from two hundred to four hundred feet. At a mile from its mouth, the latter, although still narrow, enlarges and terminates abruptly at the shore of the bay between high hills."

Little Salmon River.

"For two miles from the Upper falls, passing the Little falls, and as far down as the Lower falls, little else is met than a grey clay-slate, frequently tinted with green and blue, and somewhat indurated. For three miles below the falls, passing the points known as "The Long Eddy" and "The Key-hole," the only rocks seen were thick homogeneous beds of cherty or jaspery slate (variegated with red, purple, and grey colors, and sometimes beautifully striped with various shades), except for a short distance, where

the stream crosses beds of purplish and greenish slate, holding shining films of chlorite. Half a mile from the mill the grey clay-slates noticed above were again met with, and from the mill to the bay shore are re-crossed the micaceous slates, grits, and conglomerates observed on the upper part of the stream. On the shore eastward of the entrance of the river a small quantity of copper ore, associated with much iron pyrites, occurs in the slates, but no regular vein was seen."

Albert County

Our observations in that part of St. John County which lies to the eastward of Little Salmon River, and in Albert County, have not been sufficient to enable us to speak with certainty of the relations of the different strata therein met with. They are, however, such as to indicate an extension in this direction of the rocks above described as occurring on Little Salmon River, probably to Shepody Mountain, the eastern limit of this metamorphic belt. Along the coast between Little Salmon River and Point Wolf, the rocks are similar to those on the lower part of that stream, being chiefly micaceous slates, of green, red and purple colors and of more or less talcoid aspect, with chloritic slates and grits, the first named slates containing at some points large veins of quartz, and at others smaller veins containing blood-red calcite, specular iron or asbestus. It is among these rocks and the large masses of diorite which at the Vernon Mines and elsewhere are associated with them, that the more important veins of copper ore occurring in this region have been found. Farther to the north, along the Shepody road, are talco-micaceous slates and imperfect gneisses (composed of quartz, pink feldspar and a pale green chloritie mineral, with occasionally a little hornblende) which probably represent the somewhat similar beds occurring in the series at West Beach and Black River; the space between the two being occupied by grey slates and pale grey cherty felsites. To the eastward of Point Wolf, beds similar to the above in their general aspect may be seen about Great Salmon River, Crooked Creek and elsewhere through the hilly district terminating in Shepody Mountain, but they are separated from the coast by heavy outlying masses of Lower Carboniferous sediments.

Copper ores.

Beds bearing much resemblance to those occurring near the coast in Albert County have also been observed in the northern part of the same county, in the parish of Elgin, but have not been sufficiently studied to require further mention here.

CRYSTALLINE ROCKS OF GRAND MANAN.

Grand Manan

Description by Dr. Gesner.

The first published observations on the geology of Grand Manan are those of Dr. Gesner, who, in his first report to the Legislature of New Brunswick, in describing the general topographical features of the island, added some details of its geological structure. These latter were mostly con-

fined to the exterior belt of trappean rocks which form the principal portion of the island, and which, as shewn in the sequel, are probably of Triassic age; the formations which skirt its southern shore, and re-appear in the adjoining islands, being described as consisting of greywacke, talcose and hornblende slates, together with schistose rocks containing chlorite, and at one point, beds of highly crystalline limestone; all of the above rocks being in attitudes evidencing great disturbance, and being at many points intersected by dykes or masses of intrusive igneous rocks. No attempt was made to separate or trace the different belts thus recognized, nor to co-ordinate them with those of the mainland. In the geological map of the late Dr. Robb, probably from inferences based on the observations of Dr. Gesner, the same portion of the island is represented as of Cambrian age. The first accurate descriptions of the island in question are those contained in an Appendix to the second edition of the Acadian Geology of Dr. Dawson, wherein Professor A. E. Verrill, of Yale College, at the request of the author, gives a summary of such notes as he had been able to take during several visits to the island, not, however, made with a view to the study of its geological structure. In the paper referred to, Professor Verrill points out the unconformability of the two formations previously noticed by Dr. Gesner, at the same time offering the conjecture that the more recent, judged by appearances alone, may be of Devonian age. No reference, however, is made to the age of the older groups, these latter being described as occupying the belt of low land and the shore cliffs from Whale Cove along the eastern shore of the island, to and beyond Grand Harbor, together with the greater part of the small islands off the east side of Grand Manan; and as consisting of talcose and clay-slates, mostly greyish but sometimes black, calcareous grits, and altered grey sandstones, the latter at one or two points containing black and fissile carbonaceous shales, the dip of the whole being variable and irregular. In connection with the last named rocks, on one of the smaller islands, were found to occur enormous masses of white quartz, one hundred feet or more in breadth, and on another the crystalline limestone recognized by Dr. Gesner. All of the above series were found to be highly altered, much distorted and broken, as well as cut through by numerous immense dykes and masses of trap. In commenting on these observations of Professor Verrill Dr. Dawson has offered the conjecture that the series in question is the equivalent either of the Acadian (St. John) group, or of the Kingston group. It will appear from the following notes that the latter conjecture, as applied to a portion of the strata under consideration, will probably be verified, but that the greater part of these approach in character more nearly to the Huronian rocks than to any yet recognised on the mainland of New Brunswick.

Map of Dr. Robb.

Description of Prof. Verrill.

The following observations on the geology of Grand Manan and the adjacent islands were made during a visit of a few weeks' duration in the

month of August, 1870. Though this time was not found to be sufficient to work out all the details of structure, enough information was obtained to indicate the general range and character of the different groups represented.

Limits of older rocks.

The older rocks of the island of Grand Manan occupy a comparatively narrow but very irregular belt of land skirting its eastern shore, about twelve miles in length and from a few yards only to one mile in breadth. Their northern limit is a tolerably regular line, extending through the island with a southwesterly course, from Whale Cove to Seal Cove, while their southern presents a series of headlands and more or less projecting points, separated by corresponding indentations. As a whole, the area in question, as compared with that of the trappean rocks on the western side of the island, is low, and over much of its extent is a nearly level flat, not more than from fifteen to twenty feet above high-tide level.

Whale Cove.

The best exposures to be met with of these older rocks are those which occur in the peninsula separating Flagg's Cove from Whale Cove. The northern side of the latter indentation is composed of augitic traps and amygdaloid of the Triassic period; its southern is an abrupt wall of rock of grey and greenish-grey colors, which is in part fine grained and feldspathic, but mostly granular and imperfectly crystalline, consisting in nearly equal proportions of white feldspar and a dark green mineral, which is probably a variety of hornblende. Similar greenish-grey rocks, sometimes containing hornblende or chlorite, form the promontory of Fish Head, as well as many of the sea-cliffs between the latter and the Swallow-tail Light. Near the former the rocks are hard, more or less epidotic, and very much broken, the stratification being very obscure, but in approaching the headland upon which the light-house is built, greater diversity is seen in the composition of the beds, and the layers of sedimentation become more evident. The rocks along this portion of the peninsula consist in part of dull grey feldspathic slates, and in part of imperfectly crystalline more or less chloritic schists of a dark green color, more rarely of grey silico-feldspathic beds, which are somewhat calcareous, the strata often dipping at low angles, but with great irregularities, and apparently forming a succession of gentle folds. Contained in these schistose rocks at one or two points, are beds or layers of very irregular size, varying from two to twenty feet in thickness, of greenish-grey and reddish-grey, pale pink-weathering feldspathic rock, some of which contains numerous rounded fragments of pale red feldspar together with chlorite in a grey feldspathic paste, while others are more uniform in character and approach a pale red felsite. These felsites appear to be included in the schistose rocks in the form of lenticular masses, and seem to partake of the nature of veins rather than of beds. Small angular fragments or concretionary masses, about half an inch in diameter, of similar color and composition, are also sometimes contained in the hard grey shales, giving to the latter the appearance of a conglomerate. Faults are of common occurence

Fish Head.

throughout the series, the lines of fracture being often occupied by dykes of intrusive diorite; while at one point are contained, in coarse greenish-grey somewhat calcareous beds, several veins from one inch to four feet in thickness of pale pink and white barytes, associated with small quantities of galena and sulphuret of copper. The strata above described in their general aspect resemble those of the lower part of the Kingston group, as seen in the La Tête peninsula and the Western Isles, more nearly than those of any other formation with which we are acquainted on the mainland, but differ from it in the absence of great masses of interstratified diorite and the more sparing occurrence of pale colored felsites. In approaching the headland on which stands the Swallow-tail Light, beds approaching more nearly in character to those of the upper part of the Kingston group come into view. These consist of greenish-grey imperfectly syenitic gneisses and grey slates of considerable thickness, overlying pale grey feldspathic gneisses and dioritic schists, the first named rocks being intersected by veins of quartz containing dark green granular chlorite. These beds, on their northern side, are sometimes nearly horizontal, being thrown into a series of low folds, but in the opposite direction are more inclined, the dip gradually increasing to N. 10° E. — 60°. They here form the principal portion of the higher land immediately in the rear of Spragg's (or Pette's) Cove, as well as a portion of the promontory upon which the light-house stands, and which bounds this indentation on its eastern side. In this long and narrow neck of land still lower beds appear, being hard grey schistose feldspathic and quartzose rocks, containing an admixture of chlorite, and hard grey shales, having a northerly dip. They bear some resemblance to those described above as occurring about Fish Head and Whale Cove, and are nearly bisected by a dyke of columnar trap, similar to those which are so abundant on the western side of the island. Swallow-tail Light.

The indentation of Spragg's or Pette's Cove marks the line of separation between two groups of rocks of very dissimilar character, which, however, here appear to be conformable and to be connected with each other by intermediate beds. Of these, the first is that above described as resembling the Kingston group; the second, which includes a large proportion of the remaining older rocks of Grand Manan and the adjacent islands, approximates more nearly to those of the Coldbrook and Coastal groups, being much more strongly schistose, with an abundance of mica, as well as exhibiting much greater variety in composition and color. Spragg's Cove

The contrast between these two groups as seen on the opposite shores of the cove in question is very striking, for while the one, being that upon which the light-house stands, shews the nearly uniform greenish grey-color which characterises much of the coast to the northward, the low bluffs and ledges which bound the same basin on the south at once attract attention by their almost snowy whiteness. The rocks to which this appearance is due are pale liver-grey, very white-weathering micaceous or nacreous slates, which

are soft and somewhat unctuous, and contain numerous veins of brownish yellow spar, which are approximately parallel to each other but oblique to the bedding. The latter is here N. 20° E. < 50°, the planes of deposition being intersected by a strong slaty cleavage, dipping S. 80° W. < 80°. Near the eastern side of the cove, the contact of the two groups in question may be seen, but owing to faults and the inaccessible character of the shore, their true relations are somewhat difficult to determine. The nearly vertical wall of rock which here rises from the sea, is for the most part composed of coarse grey sandstones, portions of which are filled with small spangles of black mica. These appear to be connected with the feldspathic and quartzose rocks and calcareous grits already described as occurring to the northward of them, but on descending to the foot of the cliffs, other arenaceous beds of somewhat similar character and of a yellowish-grey color, with incrusting layers of mammillary peroxide of iron and quartz, may be seen to pass into and alternate with pale grey fine grained nacreous slates, while both are very irregularly interbedded with thin layers of dark grey and black slate. The dip of these beds, which have no great thickness, is about N. < 40°. On descending in the series, they are found to become less coarse, the nacreous slates being interstratified with dark grey pyritous and somewhat micaceous fine grained sandstones, and dark grey to black splintery shales, having the surfaces finely striated and dipping N. 70 W. < 10°. Separated from these beds by a fault, but having the same dip. and apparently underlying them, are grey somewhat micaceous and ochreous shales, which in turn rest upon a thin bed of pale grey impure and slaty dolomite, the latter being very irregular in dip and somewhat silicious. A beach a few rods only in breadth separates these calcareous beds from the slates which form the southern side of the cove.

Contact of formations.

The last named beds form a portion of a series embracing the greater part of the headland intervening between Spragg's or Pette's and Flagg's Cove. In passing along the shore of this promontory on its northern side, the white-weathering mica-slates, which form the southern side of the first named haven are found to have a breadth of several rods of very uniform character; beneath these are about twenty feet of dark grey and black fine grained and splintery shales, which are somewhat graphitic, and which intervene between the first named micaceous strata and a series of hard grey somewhat slaty sandstones. These latter, which have a breadth of about two hundred feet, also include several thin beds of black slate, and towards their base become somewhat coarser, passing into a grey grit and conglomerate. There is then a fault, beyond which coarse grey and purplish-grey sandy shales and slaty sandstones, with thin beds of conglomerate, form the shore for several rods, alternating with hard grey light-weathering nacreous slates. Both the coarser and the finer beds vary somewhat in color, the usual pale grey tint being often replaced by shades of green and purple. These last beds are

Spragg's Cove.

most abundant towards the extremity of the point, where many of them are filled with nodules and small irregular ochreous spots, and are traversed by veins of brownish-yellow spar. The lowest strata met with here have a dip N. 30° E. < 60°.

Passing to the other side of the promontory under consideration, the series above described is again met with in the low bluffs which form the eastern limit of Flagg's Cove, the general succession being the same as that of Pette's Cove, but with some differences in the character as well as in the relations of the beds. On ascending in the series, as here exposed, the purple beds are sometimes seen to be conspicuously marked by narrow alternating bands of color, which are wavy and often corrugated, the general dip being N. 20° E. Interstratified with these, and exhibiting similar corrugations, are fine grained banded black slates, some of which contain numerous pebbles, from one to six inches in diameter, of pale grey flinty felsite. In approaching the settlement, here spread along the shore, somewhat finer black and dark purple slates appear, in which these pebbles are wanting, but which exhibit the same ribbanded aspect, and similar frequent and abrupt corrugations ; some of the beds being filled with cubical crystals of pyrites, while others are traversed by quartz veins containing epidote. Towards the steamboat-wharf higher and coarser beds appear, being grey feldspathic sandstones similar to those of Pette's Cove, having a general northerly dip, but with many undulations. In the low bluffs which skirt the shore beyond this wharf these arenaceous beds, which vary from a sandstone to a pale grey quartzite, and are somewhat micaceous, alternate with thin layers of fine bedded fissile dark grey shale, both being thrown into a series of low folds. Near the head of the cove, the highest beds exposed upon this, the eastern shore, are finely bedded fissile grey and dark grey slates, which are pyritous, and marked by alternating black and pale grey somewhat sandy bands, from a quarter of an inch to an inch in thickness. The beds are much contorted, but where most regular dip N. 70° E. < 50°. Flagg's Cove.

Between the strata above described and those which form the western shore of the same indentation, there is a considerable interval in which no rock exposures appear, this interval being a part of the isthmus about a mile in width, which extends across from Whale Cove to Flagg's Cove, and separates the peninsula of Fish Head and the Swallow-tail from the mainland of Grand Manan. The space in question is probably underlaid in part by red sandstones of Mesozoic age, indications of these being seen upon the beach at Whale Cove, while on the western side of Flagg's Cove the traps of the same formation come down to within a few rods of the shore. The older rocks are here confined to a narrow belt near the water's edge, and mostly covered by the tide. Near Drake's wharf these latter, as disclosed at low water, were found to be rather coarse grained imperfectly crystalline schistose rocks, consisting of coarse white-weathering arenaceous beds, alternating with finer

greenish chloritic layers, both exhibiting a honey-combed appearance due to the removal of small oval or oblong nodules of an inch or less in length and of a somewhat sandy calcareous material, which are disseminated through the mass of the rock. With these are also some finer grained pale grey beds filled with numerous little crystalline specks of a brownish-yellow color, the whole series being nearly vertical (dip of strata S. 40° W. $< 85^{\circ}$) with a strong slaty cleavage dipping W. 10° N. $< 50^{\circ}$. Rocks very closely resembling these are seen on some of the smaller islands to the southward, and will be described in the sequel.

The next beds which appear along the western shore of Flagg's Cove, are separated from the last by an interval of about a quarter of a mile. They consist of pale grey light-weathering felsites, alternating with coarse grey feldspathic sandstones, both much broken and seamed with quartz, but having a general dip about N. 50° E. $< 80^{\circ}$. The shore for some distance is then low, and mostly covered with salt-marsh. To the south of this, however, and along the road to the post-office at Woodward's Cove, the rocks are again exposed, and consist of grey and bluish-grey light-weathering feldspathic beds, which are more or less slaty, and which vary in texture, being sometimes coarse grained and porphyritic. Towards the harbor last mentioned these coarser beds are more frequent, and at the same time more silicious. They here form a series of low ledges running out towards the sea, beneath which they are probably connected with those of Nantucket Island, to be presently described. Somewhat similar rocks appear at intervals along the road connecting Woodward's Cove with Grand Harbor, being hard bluish-grey feldspathic grits, which at the first-named haven may be seen to overlie bluish-grey felsites and grey white-weathering feldspathic shales, the dip at this point varying from N. to N. 20° E. $< 20^{\circ}$.

Woodward's Cove.

Grand Harbor.

The basin of Grand Harbor is by far the largest of the many indentations which diversify the eastern coast of Grand Manan. Its northern side is bounded by a rocky promontory running out towards Ross Island, this latter being the eastern side of the same indentation, while the two are separated by a narrow channel navigable at high water. Our stay upon Grand Manan was not sufficiently long to allow of an examination of either of these, but their general character may be inferred from that of the adjacent coast and islands. A good view of the different rocks which characterize the former may be seen on the western side of Grand Harbor and along the shore between this basin and the promontory of Red Head.

The first exposures met with to the south of the settlement at the head of the harbor consist of fine grained greenish-grey schistose rocks, the surfaces of which are roughened by nodular projections, and which are intersected by calcareous veins. With these are also grey feldspathic grits, the beds being sometimes vertical, but mostly inclining northward at a high angle, and with many irregularities. These rocks, in numerous alternations, form

low ledges along the shore for a considerable distance, being throughout characterized by a strong slaty cleavage, and being often more or less concretionary. They are followed to the south by greenish-grey feldspathic schists, varying in texture from fine to coarse, with which are also some pale purplish shales, and feldspathic and quartzose rocks of similar color, the dip being apparently N. 60° E. < 40°. Beyond a small cove and a wharf, known as Cheney's wharf, the purple tint becomes more decided, the rocks being charged with epidotic matter, and more or less amygdaloidal. From this point to the next cove and wharf (Inglis's), the ledges along the shore are a succession of fine grained greenish and purplish dioritic rocks, which are in some parts amygdaloidal, and in others banded and mottled with various shades, while some layers contain epidote, or are covered by an incrustation of specular iron. These beds are schistose, but the stratification is very irregular and difficult to determine. In advancing along the shore they are found to include at one point pale grey, somewhat talcose beds, associated with others which are pale pink, feldspathic, and somewhat granitoid, holding veins of quartz and granular chlorite. There is then an interval of about a quarter of a mile around a curving beach, beyond which appear purplish and greenish-grey unctuous talco-feldspathic rocks and grey felsite, the former dipping N. 70° E. < 60°, with strong slaty cleavage. Beyond these beds, but higher in the series, and extending towards the entrance of the harbor, are greenish-grey and purplish schistose rocks, being the same as those before noted on the other side of the beach. They here present the same chloritic and epidotic character, but include some beds which are hard and filled with amygdules of white quartz, and others covered with films of dark green chlorite, while the dip is much more regular, being E. < 70°. At the mouth of the harbor, but separated by an interval of a few rods from the last noted rocks, are purple amygdaloidal sandstones purple and pale grey slaty conglomerate, both being covered with numerous blotches of different sizes, the layers being much crumpled by pressure, but dipping about N. 60° E. < 30° to 50°.

Dioritic and epidctic rock.

The western side of the entrance of Grand Harbor is marked by a small projecting headland, known as Mike's Point, from which the shore begins to recede in the direction of Red Head and Benson's Cove. In passing around this promontory, which is in part made up of the sandstones and conglomerates above described, a return is made to higher members of the series, these being dull grey somewhat concretionary chloritic rocks, with strong slaty cleavage and indistinct bedding (dip N. 40° E. < 50), similar to those described above as occurring along the western side of the harbor towards its head. A long curving beach then succeeds, separating Mike's Point from Oxnard's Point, the latter a still larger promontory a mile or so westward of the first. The first beds met with beyond this beach are coarse grained grey schistose rocks, with wavy laminæ, and dipping E. < 30°. They overlie

Mike's Point.

a thick series of greenish and purple shales, also with wavy laminæ, the purple beds being covered with films of chlorite and pale-colored irregular blotches. The succession from this point southwards is a descending one, the last named beds being underlaid by about thirty feet of pale grey unctuous slate, which in turn rests upon dark green chloritic slates, alternating with grey and purple beds, all with strong slaty cleavage and a wavy lamination.

Oxnard's Point These rocks form the upper or eastern side of Oxnard's Point, this headland itself being composed of pinkish and grey felsites, which are sometimes porphyritic, alternating with greenish chloritic and epidotic rocks and grey epidotic shales. These underlie the purple beds above alluded to with a dip about E. < 40°–50°, and are themselves underlaid, in a cove beyond the point, by finer and more evenly bedded somewhat unctuous rocks, similar to those on the eastern side of the promontory, being composed of a granular admixture of a talcoid mineral and quartz, and dipping N. 60° E. < 50°. Another long curving beach, nearly a mile in length, then succeeds, in crossing which a few ledges may be seen at low water. The greater part of these occurs in the first quarter of a mile, being pale yellowish-grey and greenish-grey feldspathic beds, which vary from a fine grained slaty felsite to a granitoid grit, the latter containing an admixture of a talcoid mineral and quartz. The dip of these beds is N. 10 W. < 50°, the strike corresponding nearly with the trend of the shore.

After passing the beach last described, the shore again becomes rocky, and trends to the westward, running out in a series of low bluffs to the promonotory of Red Head. The first beds met with in passing along these bluffs are pale bluish-grey feldspathic rocks, filled with narrow riband-like bands of color, and exhibiting numerous and abrupt plications. Somewhat similar beds, of a pale liver-grey color, but including others having a pale purplish tint, and similarly corrugated, are seen along the shore for several rods; but in

Red Head. approaching Red Head appear to be underlaid by rather coarse grained grey and green chloritic rocks, which are ochre-stained and seamed with veins of spar. The dip of these beds is N. 40 W. < 50°. Still further in the same direction there is a return to the higher beds, the grey ribanded slates again coming out upon the shore, and extending nearly to the extremity of the promontory. They here exhibit very fine alternations of grey sandy and greenish fine grained layers, from one to two inches in thickness, some portions of which are so charged with red ochre as to afford a mineral paint, and to give to the bluffs the conspicuous color which has suggested their name. The highest beds met with here are soft and rubbly, having been worn into caves by the action of the sea, and have in general a more modern aspect than most of those which appear along the eastern side of Grand Manan, but at their base may be seen to alternate with the more crystalline chloritic rocks, both being similarly corrugated, but having a general dip about N. 40° W. < 40°—70°. In their ribanded character, and the numerous flexures to which they have

been subjected, they bear much resemblance to the strata already described as occurring along the eastern shore of Flagg's Cove, towards the other end of the island; a resemblance which is still further indicated by the occurrence with these grey ochreous rocks, of a few beds of red and grey feldspathic sandstone coated with specular iron, and others of dark grey somewhat plumbaginous shale.

On the western side of Red Head, at the distance of a few rods only from this promontory, the rocks above described, dipping northerly at an angle from 30° to 40°, meet and are covered by a very coarse conglomerate made up of large fragments of coarse green augitic trap, which underlies and passes into massive rocks of similar composition, and of a columnar structure, being a part of the great Mesozoic belt which traverses the entire western side of Grand Manan, and which, at a distance of a few rods from the point in question, rises to the height of two hundred feet. **Mesozoic rocks.**

As already stated on a preceding page, our visit to Grand Manan was not sufficiently long to permit an examination of all the numerous islands which skirt its eastern shore, and are often difficult of access, from adverse winds and tides. The following observations are such as we were able to obtain in the limited time at our disposal.

The most northerly of these islands upon which we have landed, is Nantucket Island, which lies off a little to the east and south of Woodward's Cove, and which is remarkable for the conspicuous white ledges which form its eastern shore. **Nantucket Island.** These, upon examination, were found to consist of pale pinkish-grey white-weathering quarzites, having in parts the fineness and general aspect of a vein-stone, but in others a laminated structure, the whole covering an area of over a furlong in breadth, and dipping W. 10° N. < 20°. Similar white ledges are also seen on the mainland near by. Those of the island are underlaid by soft greenish-grey, somewhat unctuous or talcoid slates, dipping W. < 50°. These latter beds may also be seen skirting the southern shore of the island, while through its centre, and to the northward of them, is a conspicuous ridge of the quartzites, which also re-appear in Gull Rock, and through it are connected with the strata of Ross Island.

Upon the last named island we have not been able to make any extended examinations, having touched at two places only in sailing up its western side towards the settlement of Grand Harbor. **Ross Island.** The first of these points is the indentation known as Chalk Cove, a name probably suggested by an outcrop at its head of white quartz rock, similar to that of Nantucket Island. The breadth of this mass is here much reduced, not being more than twenty or thirty feet, while its attitude is more inclined. On its northern side it may be seen to rest upon fine black fissile shales and gray shales, dipping S. 30° W. < 30°, while on its southern, but separated by the waters of the cove, are the green chloritic schists, dipping S. 30° W. < 40°. The second point examined is that known as Newton's wharf, where the ledges

on the shore consist of greenish-grey hornblendic and dioritic schist, dipping S. 50° E. < 40°.

Big Duck Island.

To the eastward of the islands above referred to, but separated by an interval of several miles, is Big Duck Island, the most easterly of the numerous islets under consideration. In crossing the northern end of this island, an excellent section of the rocks composing it may be seen, the succession being as follows, from west to east :—

Bluish-gray slightly unctuous feldspathic schists, and pale grey light-weathering beds (dolomites ?) both filled with small crystals of brown-spar or spathic iron. Their dip is E. 10° N. <40°, the cleavage, which is very marked, being W. <60°.

Grey conglomerate, in which the paste resembles that of the last named beds, the pebbles being large and distinct, of a bluish color, and often very coarsely porphyritic, with large pale-colored angular blotches. Dip and cleavage as above.

Pale gray white-weathering nacreous mica-slates, filled with numerous brownish-yellow crystals resembling spathic iron, nearly vertical.

Greenish-grey shales and hard grey sandy shales, alternating with nacreous slates in nearly vertical beds.

Green and purple shales, filled with small yellowish-brown angular spots and minute black crystals, dipping towards and beneath the above, W. 20° S. < 80°.

Shales similar to the last, but becoming coarser towards their base, and filled with round nut-like nodules of grey rusty-weathering sparry matter (spathic iron ?) and chlorite. The spar has been partly removed by the action of the sea, leaving the surface honey-combed with numerous holes two or more inches deep. These beds are the same as those of Flagg's Cove upon Grand Manan. They have a breadth of over one hundred rods, including some fine and very fissile shales.

Purple grits, alternating with shales similar to the above, but frequently filled with little green specks together with scales of specular iron. There is a considerable breadth of these, followed by

Coarse purplish-grey quartzose grits. These rocks, which form the eastern shore of the island, are the lowest beds exposed, their dip being W. < 60°.

Large quartz veins cut the beds ef the above series at several points, but do not appear to be metalliferous.

The strata of Big Duck Island are evidently a portion of the same series with those already described upon the shores of Flagg's Cove and Spragg's Cove, with which they are probably connected through Low and High Duck Islands and Long Island. Upon these we have not landed, but are informed that they present features similar to those of Big Duck Island.

White Head Island.

White Head Island, which lies to the south and east of the entrance of Grand Harbor, we have not been able to visit, but in sailing along its southern side, the conspicuous white cliffs which form its western portion, and from which it derives its name, may be distinctly seen at a distance of several miles. They are, without doubt, composed of quartz rocks similar to those which have already been described on Nantucket and Ross Islands.

To the south and west of White Island lies a small group known as

the Three Islands. On the larger of these, known as Outer or Kent's Island, is a series of rocks somewhat different from any which we have elsewhere met with in the vicinity of Grand Manan. These, as seen on the western side of the island, are pale-weathering crystalline felsites of greenish-grey and pinkish colors, which are in some parts somewhat talcoid, alternating with greenish chloritic and purplish schists and diorite, and including also several beds of crystalline limestone. These latter are mostly light colored, being mottled with shades of green, grey, or pink, and containing, generally, a considerable admixture of quartz. Their thickness is small but extremely variable, the whole series being very irregular, with a general dip about S. 40° E. < 80° < 90.° They cross the island obliquely, and may be seen on its eastern side. Three Islands.

The only other islands upon which we have landed are the Wood Islands, which lie to the north and west of those last described, and immediately southward of the promontory of Red Head. Upon Outer Wood Island we have not made any extended examinations, but in touching its eastern shore, found the cliffs here exposed to be composed of hard greenish-grey silico-feldspathic rocks, often filled with little black specks, and in parts approaching a quartzite. These rocks are very massive and uniform, as far as seen by us, and are without any evident stratification, though appearing to dip southward at a high angle. The rocks of Inner Wood Island are quite different in character, and exhibit much greater diversity. The strata exposed upon the shore at the northeastern end of the latter, are of a dark green color, and consist of a mixture of hornblende and epidote, with a little feldspar, and are filled with epidotic veins. In passing along this shore to the western side of the island, the first rocks met with are coarse feldspathic and dioritic rocks, varying in color from bright green to purple, and containing innumerable blotches or amygdules of calcite and epidote. These amygdaloidal rocks skirt the shore for about a quarter of a mile, then passing into a reddish and purplish amygdaloidal sandstone, dipping about N. 40° E. < 40°. A few rods further in the same direction are other sandstones of grey and purple colors, which are more or less calcareous, and conspicuously marked by parallel bands of a darker color, the dip being N. 20° E. < 40°, but somewhat irregular. Beyond these are deep red and purplish-red fine grained banded sandstones, alternating with beds of pale grey somewhat unctuous feldspathic schist. Dark green hornblendic and dioritic rocks, similar to those first seen on the opposite side of the island, then come into view (their fissures being filled with numerous seams of quartz), and are associated with purplish-grey rocks of similar character. These form the shore for another quarter of a mile, at some points exhibiting a tendency to a columnar structure. They may then be seen to directly overlie purple rocks, which vary from fine sandstone or grit to a fine conglomerate, distinctly stratified and dipping N. 60° E. < 60°. These sandstones are conspicuously banded with narrow veins, from two to three inches in length and about a quarter of an inch wide, composed of fibrous calcite

Outer Wood Island.

Inner Wood Island.

or satin spar, which appear to occupy a series of parallel and overlapping lenticular cavities of similar dimensions, arranged at right angles, or nearly so, to the bedding of the rock. Similar purple sediments, varying from a conglomerate, through sandstones, to soft purple-red sandy shales, and dipping N. 20° E. < 40°, form the remainder of this shore as far as examined; but include, at one or two points, small beds of pale grey unctuous or feldspathic rocks, also containing lenticular veins of satin-spar, and apparently conformable in dip.

Summary. In reviewing the general features presented by the rocks of Grand Manan and the adjacent islands, the resemblance which a portion of these, including the variously colored micaceous or nacreous slates, bears to those which occur along the coast in the eastern part of St. John and Albert Counties, will be apparent, and it is probable that the two belong to the same horizon. It has been stated that the rocks which form the northeastern end of the main island (north of the Swallow-tail Light), and which include a thick series of gray indurated slates may represent a portion of the Kingston group; but it is also possible that they may be the same as the grey slates or argillites which on the Little Salmon River, in St. John County, lie above green and purple nacreous slates similar to those of Grand Manan. The resemblance of these latter to those of the Quebec group, in Canada, is also very marked.

Huronian Series in Northern King's County.

A plateau of intrusive granite connected with that of the Nerepis range, and extending southerly from the main body of this granite until met by the rocks of the Kingston group on the West Branch of the Musquash River, divides the Huronian rocks of the Coastal type, already described about the head-waters of Lepreau and New Rivers, from those of the Nerepis River and the Long Reach in the northern portion of King's County.

The most complete succession of the rocks of this series in the district under consideration, is to be met with along the lower part of the Nerepis River. Nerepis River and on the line of the Western Extension Railway. They here occupy most of the interval between McKenzie's Inn and Belyea's Inn, on the post-road to Fredericton, and have a surface breadth of about seventeen thousand feet. Their thickness it is impossible to estimate, the exposures being insufficient, and the beds evidently repeated by faulting and folding for the whole distance. Other obstacles in making such an estimate are the strong slaty cleavage by which the stratification of the slates, conglomerates and grits, of which the series is chiefly composed, is obscured, and the crystalline aspect of the grits, which cannot always be distinguished from true gneiss or granite. These granitoid grits, stand out above the general level of the land at numerous points, and form ridges, the extremities of which have been cut through in the construction of the railway. The

strata in question are separated to the north of McKenzie's from the granite hills by a wide belt of fossiliferous Upper Silurian beds and the hills of petrosilex about Eagle Cliff, described in the last chapter, and are followed on the south, near Belyea's, by schistose rocks of the Kingston group.

The following surface measurements, obtained by pacing, will indicate the general character and arrangement of the beds in this district:—

Section near Belyea's Inn.

		Traverse measure. Feet.
Pale olive-green slaty conglomerate and slate, with heavy beds or dykes of diorite and dark grey slate. In these and the following slates are veins holding blende, galena, and copper-pyrites		850
Purple clay-slate, spotted with buff colored films of steatitic matter, and having dark grey clay-slates and diorites on the southern side. Dip at this part N. 20° W. < 70°		600
Dark purplish and grey clay-slates, with scales of chlorite; also several beds or dykes of diorite		420
The same, with talcoid slate. Dip S. 10° E. < 70°		840
Grey granitoid grit		700
Purplish sandy slates and purple porphyritic clay-slate		520
The same with reddish-grey sandy slates		600
Grey granitoid grit, partly slaty (including 100 feet in which the rocks are concealed)		1,260
Measures concealed, supposed to be clay-slates		840
Olive and purplish-grey clay-slate, partly porphyritic, and dipping N. 30° W. < 50°		600
Grey granitoid grits. Dip northward < 60°		
Measures concealed, supposed to be grits		500
Brown conglomerate		100
Measures concealed, supposed to be mostly clay-slates		1,000
Grey granitoid grits		20
Coarse purplish-brown conglomerate, one exposure in a space of		150
Measures concealed		2,600
Grey granitoid grits		250
Fault, cutting off the grits, to which succeed dark grey shales, with grey silicious layers. These strata resemble those of the St. John group, and represent a space of		1,500
A hill then meets the track of the railway. On the west side of it are exposures of brownish-red conglomerate	250	
Dark grey clay-slates, dipping S. 70° W. < 70°	100	
Measures concealed	350	
Grey clay-slates	100	
Brownish-red conglomerate	740	
Purple porphyritic clay-slates	380	
Greenish-grey clay-slates	240	
Dark grey schistose grits	480	
	——	2,640

In this hill, where the strata have the aspect of the Coastal group, there are probably faults causing a partial repetition of the beds. For a space of 1,400 feet across the strike of the beds, the same series may

be seen outcropping on the top of the hills west of Belyea's Inn. Here the schistose grits continue, with a dip S. 20° W. < 50°, for some distance, until met on the south by greenish-white and pinkish limestones, which are in part an imperfect granular marble. These are succeeded, further on, in the bottom of a ravine, by dark purplish slates and olive-green chloritic slates, dipping S. 20° E. < 70°. The above strata have a breadth of about 1,400

The ravine above named gives passage to a small brook flowing into the St. John River a little below Belyea's Inn, and marks the boundary between the Coastal and Kingston types of Huronian rocks. Its southern wall presents to view a mass of hard dark grey dioritic and petrosilicious slates, which thence extend nearly to Brundage's Point, where diorite and felsite beds are abundantly intercalated with the slates.

In a traverse of the woodlands intervening between Brittain's stream and the Nerepis, made on a wood-road crossing the country about half a mile south of McKenzie's, the Huronian series may be crossed diagonally. Greenish-grey clay-slates form the face of a hill rising from the river, and dip N. 60° W. < 70° and N. 50° W. < 80°. Upon these, to the southward, rest granitoid grits and slate-conglomerates similar to those seen along the railroad track in the valley of the Nerepis, and having a course W. S. W. The road runs along a ridge of these grits through the woods for some distance, to a little valley (at the head of Nace's Brook), where porphyritic red clay-slates and red slaty conglomerates appear. Passing a piece of flat land without rock exposures, the road meets a broad flat ridge of woodland; here greenish-grey clay-slates are exposed with a dip S. 80° E. < 90°. Along the southern slope of the ridge, around which the road runs, are numerous fragments of diorite, dark petrosilicious rock and slate-conglomerate. Beyond this ridge, the valley of Brittain's stream opens out into a broad flat, covered with granite boulders. On the further side of the stream high hills, which probably mark the border of the granite tract, rise boldly from the flat land of the valley.

Britain's stream.

To the eastward of the line of section given above in the valley of the Nerepis River, a belt of comparatively low land, from three to four miles in width, intervenes between the granite hills and the Long Reach of the St. John River. Along the line of settlements near these ridges of crystalline rock, the strata, so far as exposed to view, were found to consist mainly of fossiliferous Upper Silurian slates and petrosilicious rocks, with beds of diorite, similar to those which intervene between the same hills and the Huronian rocks on the Nerepis River, above described; but to the southward of these more recent sediments, the rocks of the Coastal group again come into view, in a series of low ridges extending along the north shore of the Reach as far as where the latter widens near Jones's Creek. The most westerly point at which we have crossed these ridges is at Jesse Belyea's steam-boat landing,

Long Reach.

about four miles from the foot of the Long Reach. The moderately high hills which here overlook the river are composed of a highly feldspathic light-weathering rock, varying from red to purplish-red in color, and in composition from a fine grained sandy felsite to a granulitic grit. These rocks, which are sometimes porphyritic, have a surface breadth of nearly a furlong, and have been traced, with essentially the same features, to the islands below Jones's Creek, from which they cross to the opposite side of the river, re-appearing in Gorham's Bluff near the entrance of Belleisle Bay. It is possible that the rocks in question, which are evidently recomposed, and in some parts approach a conglomerate in character, may be an outlying member of the Lower Carboniferous series, such rocks being found at the base of that formation on the northern side of the granite hills; but no other sediments resembling those of the formation in question are met with here, and these latter appear to conform in arrangement to those of the Coastal group which accompany them. These latter were met with at several points in the low ground mid-way between the river and rear line of settlements, and consist of granitoid grits, similar to those occurring on the Nerepis below McKenzie's, being of grey and greenish-grey colors, weathering pale grey, and holding pale red feldspar, quartz, and a dark green mineral resembling chlorite. At the saw-mills near the forks of McKeel's mill-stream, in the same general range with the above, are schistose chloritic rocks of greenish-grey, reddish, and purplish colors, and containing epidotic veins, which rest upon beds of similar aspect, but holding pebbles. Their dip is irregular, but about N. 20° W. < 50°. These are not far to the north of the granulitic ridge first alluded to, which here consists of a red feldspathic paste, through which are scattered numerous crystalline grains of quartz. These rocks are followed on the south, at McKeel's mill, by purplish-grey sandstones, which also outcrop along the road in the rear of a bold ridge of land called the Devil's Back, as far as the residence of Mr. W. B. McKeel, where also ledges of grey sandstone and hard dark grey dioritic sandstone also appear, dipping southerly at an angle of about 40°. The eminence last named, which rises abruptly from the river, discloses on its summit beds of dark grey fine grained porphyritic petrosilex. Further to the eastward the purple sandstones re-appear, and form low ledges near the river as far as where the latter expands near Caton's Island. Between the mouth of Jones's Creek and the shore near this island, the following succession may be observed:— **Devil's Back.**

For about a furlong below the bridge, where the high road crosses the above named stream, are exposed low ledges of soft grey fossiliferous Upper Silurian shales, dipping S. < 60°, separated at intervals by thin beds of hard and rather coarsely crystalline diorite. To the southward of these, and partly concealed by soft slaty beds, like those above mentioned, are ridges of hard grey dioritic sandstone, followed at a short distance by grey silicious beds, dipping S. < 60°. These rocks have a considerable breadth; **Jones's Creek.**

beyond them grey dioritic and feldspathic sandstones again appear. There is then a space of about a furlong without exposures, beyond which the arenaceous beds again appear, and are immediately succeeded by beds of rather coarse and rusty crumbling diorite. These dioritic beds appear to be connected with a thick series of hard grey and dark grey light-weathering petrosilicious and feldspathic rocks, exposed to the southward of the above over a breadth of several rods. These rocks resemble those of the Coldbrook group, being mostly fine grained, without distinct stratification, and more or less porphyritic and vesicular, but some portions are schistose, having a northerly dip of about 40°. About midway between Jones's Creek and the shore facing the main channel of the river below Caton's Island, these fine grained rocks are followed by pale reddish-grey and greenish-grey white-weathering feldspathic gneiss or gneissoid grit, like some varieties of the granitoid rocks below McKenzie's on the Nerepis. These are probably Huronian strata. They present no great thickness at this point, being, after a short interval, followed on the southern side by fine grained purplish-red sandy felsites, containing particles of quartz or glassy feldspar, similar to those already noticed as extending along the northern shore of the Long Reach below the Devil's Back. The ridge of these rocks here terminates in high bluffs overlooking the shore near Caton's Island. On its southern side, where the rock is a conglomerate, holding large feldspathic pebbles enclosed in the red feldspathic base, the dip is about S. 10 E. < 80. They are here overlaid, in a small cove nearly opposite the centre of Caton's Island, by soft crumbling purple shales, containing stains of green carbonate of copper, and grey shales. On the opposite or southern side of the same cove, and filling the remaining space to the shore of the Long Reach, the following succession may be seen :—

Caton's Island

Fine grained diorite, a broad ridge covered by grey dioritic sandstone and purple slate. Dip S. < 40°.

Purplish-red conglomerate full of pebbles of red slate and reddish felsite, similar to that of the hills above.

Grey fissile shale, in thick beds finely laminated.

A chain of three small islands, lying off the mouth of Jones's Creek, and extending in the direction of Oak Point, separates the bay receiving the waters of the above named stream from the main channel of the Long Reach. Of these Caton's Island, the larger and more westerly, is composed of fossiliferous Primordial strata, dipping northerly. The second is Rocky Island. So far as examined, the latter consists of hard pale reddish-grey gneiss or feldspathic sandstone, a highly feldspathic rock of very indistinct stratification, and in some parts filled with pebbles or concretionary masses of hard grey feldspathic quartzite, some of which contain thin veins of galena. A somewhat similar but more crystalline rock forms the extremity of Oak Point, a mile or so to the eastward, being a reddish syenitic gneiss, rather

Rocky Island.

Oak Point.

coarse grained, and containing, together with much red feldspar and large grains of quartz, an admixture of hornblende and a soft green mineral. With these syenites, at the latter point, are dark fine grained diorites, very irregularly associated with the more crystalline rock in beds from five to twenty feet in thickness. The third island in the chain under consideration is Big or Foster's Island. Here the rocks are mainly red sandy felsites and feldspathic conglomerates, similar to those of the main land near Caton's Island; but beneath the latter, which dip. S. 30° W. < 40°, are lighter colored beds of similar character, portions of which are epidotic, while others contain numerous blotches of calc-spar, giving to weathered surfaces a vesicular aspect. This rock, which resembles that of Rocky Island, is very rusty, and contains large rounded fragments or boulders of grey feldspathic quartzite. On the north side of the island, and apparently below the feldspathic beds above described, are finer and more schistose rocks, consisting of red shaly conglomerates, holding fragments of green shale in a red slaty paste. The dip of these beds is irregular. Foster's Island

No rocks resembling those of the Coastal group are to be met with along the northern border of the Long Reach to the eastward of Oak Point, but on the opposite side of the river beds resembling those of the islands and hills southwestward of that promontory appear near the head of the Reach and upon either side of the entrance of Belleisle Bay. A projecting point of land, known as Gorham's Bluff, here separates the waters of the main river from those of the last named basin, and on its northern side exposes ledges of reddish granulitic grit and dark brownish-red sandy felsite, similar to that already noticed in the ridges about the Devil's Back and towards the foot of the Reach. In crossing the extremity of the bluff towards Gorham's Creek, coarse red conglomerates come into view, holding fragments of diorite, reddish granulite, etc., and resembling those of the Lower Carboniferous formation. Still farther in the same direction are finer, somewhat slaty conglomerates, in which dark green slaty fragments are imbedded in a dark red paste. These are probably of the Coastal group. They form that part of the promontory facing Belleisle Bay and Kingston Creek, and dip about E. 30° S. < 60°. Gorham's Bluff.

The strata of the Coastal type which appear on the opposite side of Belleisle Bay, are confined to a narrow belt skirting its northern shore, in the southern part of the parish of Kars. They form the greater part of a peninsula about a mile in width, separating this bay from Tenant's Cove, a small indentation from the St. John River, and are again exposed about the shores of Jenkin's Cove. On the southern side of the peninsula in question, overlooking Belleisle Bay, are low bluffs of coarse and massive brownish-red conglomerates, dipping S. 10° E. < 50°, and resembling those of the Lower Carboniferous formation, which occurs in force a few miles to the Belleisle Bay.

eastward. About a furlong of low meadow-land intervenes between these shore-bluffs and the hills which traverse the central portion of the peninsula, and at several points shows indications of being underlaid in part by soft purple shales. In rising over the ridges alluded to, which form the greater part of the peninsula, these are found to consist mainly of pale greenish-grey and purple light-weathering feldspathic schists which, by the addition of disseminated grains of quartz, often become gritty felsites. Much of this

Tenant's Cove. rock is rubbly and ochre-stained. Towards Tenant's Cove purplish beds become more abundant, and on the southern shore of this indentation include purplish-brown feldspathic conglomerates, portions of which contain fragments of cream colored slate, and are spotted with kaolinized feldspar. Both the greenish felsites alluded to above, and these purple rocks which

Jenkins's Cove bound them on either side, extend to Jenkin's Cove, the former being exposed in ridges lying to the north and east of this indentation, while the latter form low bluffs near its shore. These latter are better exposed here than farther westward, and consist of moderately coarse purple conglomerates associated with red slates, which are overlaid by a fine grained feldspathic and epidotic rock of green and purple tints; the dip of the first named beds varying from S. 70°—80° E. < 50°. In the low ground which separates these shore bluffs from the hills in the rear, are poorly exposed ledges of soft grey rubbly and dark grey shales. They form a portion of a belt of such rocks which probably extends across from Tenant's Cove, a few ledges of dark grey rusty and somewhat plumbaginous shales being visible near the Baptist church at the head of this indentation. The hills last alluded to in the rear of Jenkin's Cove are in part composed of greenish and purplish pale-weathering gritty felsites, and in part of fine grained chloritic and shaly conglomerates, with fragments of chlorite or serpentine and felsite. These rocks lie to the northward of the gritty felsites, and appear to be themselves underlaid by schistose chloritic rocks of a green color, with white-weathering films of chlorite, and a wavy lamination.

To the eastward of Jenkin's Cove we have not traced the rocks of this group, the greater portion of the shore between this point and the head of Belleisle Bay being occupied by conglomerates of the Lower Carboniferous formation. The only beds met with in this direction which may belong to the horizon of the Coastal group, are rather soft purplish shaly conglomerates, spotted with little blotches of a pale yellow color, which form a low ridge near the high road, about two miles below Belleisle Point. It is possible that some of the strata met with to the eastward in the parish of Springfield may be of the same age, but they have not been distinguished from those constituting that division of the Huronian series described in the earlier portions of this section.

THE KINGSTON GROUP.

THE assemblage of rocks to which the above name has been applied, was first described by the authors in their "Observations on the Geology of Southern New Brunswick", wherein, also, the age of the group was indicated as probably Upper Silurian, this conclusion being based chiefly on lithological and stratigraphical grounds, and the known occurrence of strata of this age associated with rocks like those of the Kingston group in eastern Maine and Nova Scotia. In making this reference, however, the authors, at the same time, stated that some of the beds in question might prove to be of a different horizon, calling especial attention to the resemblance which certain beds occurring along the north side of the Long Reach of the St. John River, and doubtfully referred to the Kingston series, bore to the schistose group skirting the coast in the eastern part of St. John County. Further investigation has shown the doubtful rocks in question to be distinct from those of the true Kingston group, which is thus limited to its more typical portions as disclosed in the Kingston peninsula, in the central part of King's County, and about the lower part of New River, in Charlotte County. It has also shown that the Kingston group itself is much older than the Upper Silurian period; for although the strata of this age are intercalated with the Kingston rocks, the intimate association of the two is evidently accidental; much of a group of strata on the Mascarene shore in Passamaquoddy Bay, which cannot be younger than the Devonian series of St. John County, and which is described in the sequel, being largely made up of the waste of the adjoining Huronian strata. Moreover, the Upper Silurian rocks in Queen's County are found to be entirely separate and distinct from those of the Kingston group. **History.**

During the last three seasons we have added considerably to what had been previously known of this peculiar belt of rocks, and can now define its limits with greater accuracy. Its northern boundary is a nearly straight line, extending through and from the Long Reach of the St. John River in King's County, to Deadman's Head in Charlotte County. Its southern boundary is parallel to this, being the course of the north shore of Kennebecasis River in the same county, (King's), continued onward to Lepreau Harbor on Mace's Bay. It is partly overlaid along the coast, from Lepreau to Deadman's Head, by strata of the Coastal group. Besides this regular belt, we have found that another band of sediments, similar to those of the lower half of the Kingston group as seen at the foot of the Long Reach on the St. John River, and which we have described as divisions 1 and 2 of the Kingston group, extends through the Mascarene peninsula and the larger islands of Passamaquoddy Bay. **Limits.**

The strata of the first named belt are well exposed at the Land's End, in the parish of Westfield, King's County, and again on New River in Charlotte

County. They appear to embrace two principal sub-groups, which are not always found in connection, are very diverse in aspect, and may, perhaps, when better known, be found to be unconformable. The lower, including divisions 1 and 2, is characterized by the prevalence of grey clay-slates, but the upper (divisions 3 and 4), is markedly gneissic. Only division 1 of this series is sufficiently well known to be sub-divided.

Synopsis.

Division 1:

a. Black shales, succeeded by grey slaty felsites, alternating with two or three bands of black clay-slates.

b. Grey slaty felsites, alternating with dark grey clay-slate, and a few dioritic beds.

c. Dark grey vesicular diorite and dioritic slate, alternating with fissile black slates and grey clay-slates, in beds from five to twenty or more feet in thickness.

Division 2:

Hard sandy grey slates and hard grey argillites, alternating with porphyritic dark grey diorite, chloritic schist and grey or pinkish felsite. These felsites are sometimes porphyritic, and often a little gneissic from the presence of mica or chlorite, but not so conspicuously so as those of division 3. There are also, in division 2, at La Tête, heavy beds of coarse grey slaty conglomerate.

Division 3:

Dark grey diorite and flesh-red felsite in frequently alternating beds. The diorites are rather fine grained, not unfrequently porphyritic and often somewhat schistose; the felsites are coarser than those of division 2, and by the addition of mica and a little quartz assume the appearance of feldspathic gneiss. Hornblende-schist and grey mica-schist are not unfrequent in this division, and grey argillites are of rarer occurrence. It also contains, at the Land's End, King's County, beds of grey gneissic conglomerate.

Division 4:

Strata similar to those of division 3, with the addition of chloritic schist, grey argillite and epidotic hornblende-schist. At the contact of this division with the Laurentian rocks, at Mace's Bay, (the only district in which its strata have been seen), are beds of reddish granitoid gneiss.

Structure.

At the Land's End the nearly vertical beds of the Kingston group lie in a sharp synclinal fold; but in the eastern part of Charlotte County the strata of the belt exposed at the Land's End slope at a lower angle towards the sea. On approaching Deadman's Head, the Kingston rocks sink down along the line of fault on its northern side, so that only division 3 is visible here and at Beaver Harbor. At none of these places are the rocks exposed in such a position as to admit of an accurate measurement of the whole series being made. Nevertheless, a general estimate of its volume may be gathered from the following consideration, viz., that at the foot of the Long Reach of the St. John River in King's County, where, as already stated, the beds are nearly or quite vertical, there is a space of about two miles

Thickness.

between the base of these rocks and the highest beds observed in the synclinal at the Land's End. Again, at New River, where this series covers a space extending from a point on the river about a mile above the post-road to the shore of Mace's Bay, the width is nearly four miles, and the southward dip of the beds averages at least 50°.

Between this portion of the Kingston group and the strata seen in La Tête Head, the whole Coastal group intervenes with a reversed, *i. e.*, northerly dip; so that we have not been able to connect the two belts of Kingston rocks which exist in Charlotte county. The exposures on the first named promontory appear to indicate that the strata are here compressed into a long and narrow synclinal fold, extending in an easterly direction through the Mascarene peninsula, between Magaguadavic River and L'Etang Harbor, and in the opposite direction through the chain of the Western Isles. Strata of similar aspect re-appear in the island of CampoBello, and constitute a portion of the northern end of the island of Grand Manan.

Details of the Kingston Group.

As stated in the general remarks, the most complete view of the character and relations of the Kingston rocks is that afforded by the Land's End, in the parish of Westfield in King's County. The locality thus named forms the southwest extremity of a rectangular and peninsular belt of land, about twenty miles in length and about five in breadth, lying between the Long Reach of the St. John River, on the one side, and the Kennebecasis Bay on the other. This peninsula is almost wholly composed of the rocks in question, which, being but scantily covered with soil, afford ample facilities for the study of the geological structure.

As seen along the shore of the Land's End, the succession of these rocks has been approximately determined as follows:—

	FEET	
At Harding's Point, forming the northwest angle of the peninsula, and at the foot of the Long Reach, the rocks are covered by hills of modified drift, but a little back from the St. John River, on the cross-road to Milkish, they rise above the superficial deposits, and consist of fine grained grey feldspathic slaty rocks, dipping S. 40° E. < 70°. They are distant about 1,000 feet from the shore of the reach, and are followed by a space, in which the measures are concealed, of	500	Section at Land's End.
Grey slaty felsite, partly slate-conglomerate and grit..	350	
Measures concealed	250	
Grey slaty felsite or feldspathic slate	100	
Measures concealed, except ten feet of grey felsite at top	350	
Grey micaceous slates..	200	
Measures concealed in a hollow	350	

These beds are followed by others of reddish-grey felsite, which, as they appear upon the shore at the Land's End, alternate repeatedly with beds

	FEET.
of hornblende-schist and chloritic schist, varying from three to twenty feet in thickness. These have a dip S. 50° E. < 80°, and a surface-breadth of about	1,000
They are followed by dioritic schist, gneiss-conglomerate with elongated pebbles, gneiss-grit and mica-schist in beds of about the same thickness as the last, having a dip S. 50° E. < 80°, and a surface-breadth of about	2,600
[At a rocky point in a cove within this space, are wedge-shaped beds or dykes of hornblende-rock, sometimes schistose and of various textures and shades of color; and a little further, grey mica-slate, gneiss-grit, and feldspathic gneiss in beds from one inch to twenty feet in thickness.]	
Beyond this point a deep valley opens out upon the shore. At a point of rocks in an indentation of the shore further south, is a fine grained dioritic schist, alternating with granulitic schist, of which some beds are filled with films apparently of chlorite. At a neighboring point, the grey conglomerate, with pebbles from an inch to a foot long, reappears, associated with feldspathic gneiss, hornblendic and dioritic schist, holding feldspar, epidote and chlorite in crystals and granular masses. The dip is nearly vertical, N. 50° W. These exposures are within a space of about	4,000
Passing on to the south side of a fishing-beach, bright silvery mica-slates may be seen, having a dip of N. 50° W. < 80°. Along towards another point, the same rock, in perpendicular beds studded with crystals of pyrites, continues to alternate with chloritic slate, dioritic gneiss and gneissoid grit. The dip here is about N. 50° W. < 60°. A gneiss-conglomerate, with round pebbles, also occurs here. The space occupied by the whole is about	2,000
Approaching the southern extremity of the Land's End, grey flinty stratified rocks and dark diorites are met with on the steep rocky shores which here border the river. Nearer to the extreme point, similar grey rocks and slaty grits occur, and at the point itself are felsites of brownish and reddish colors, associated with diorites, still dipping northward at a high angle. The space occupied is about	2,000

The structure of the Kingston beds in the area crossed by the above section appears to be that of a long trough, extending north-east and south-west, with the axis of the synclinal about the middle of the Land's End. Indications of a similar structure have been observed in other parts of the peninsula, of which the latter is the western termination. In a reconnaissance of this region, made by one of the authors in 1864, rocks similar to those above enumerated were observed at many points in the parish of Kingston, and were found to extend eastwardly into the parishes of Norton and Springfield, until concealed by overlying uncomformable sediments of the Lower Carboniferous formation. The general course of the beds is the same as at the Land's End, and throughout the peninsula these rise into low ridges separated by more or less narrow valleys. Along the southern side of the belt the rocks are chiefly gneissose, varying in color from grey to pink, and at times having the as-

Kingston.

pect of a grit or conglomerate; with these are grey flinty slates or quartzites, (which are sometimes cupriferous), pinkish-grey porphyritic felsite and dark grey diorite, being a continuation of the similar beds at the foot of the above section, and on the north shore of the Milkish. This belt of rocks extends in a remarkably straight and picturesque line of hills from the Milkish Passage to Dickie Mountain near the Finger-board in Norton, and is well seen about the villages of Clifton and Hampton. At the former locality there are associated with these rocks irregular beds of dark green granular chlorite, also, less abundantly, epidote and veins of specular iron. Beyond this range of hills, to the north, the land is for the most part lower, and is occupied by rocks similar to those of the Land's End, being pinkish and grey porphyritic felsites, alternating repeatedly with beds of dark grey diorite, dioritic schist, and thin beds of micaceous and chloritic schist,—also grey feldspathic gneiss and syenitic gneiss. Rocks of this character are common along the Middle Land road, which traverses the centre of the peninsula from east to west, and are well exposed in the town of Kingston. They extend to the eastward beyond the boundary-line between the parishes of Kingston and Springfield. The northern side of the peninsula is composed of rocks more argillaceous than those in the central and southern portions, consisting for the most part of hard grey feldspathic slates, with some micaceous slates and diorite, but is less accurately known than these latter. The line of division between these slates and the feldspathic, dioritic and gneissic rocks to the southward, crosses the indentation of Kingston Creek about midway between its mouth and the town of Kingston. **Clifton.**

The schistose rocks described above as skirting the southern shore of the Long Reach, may be better seen at the southern extremity of this great depression, where also their contact with the Coastal strata of the north side of the reach is exposed to view. This contact may be seen in a ravine which gives passage to a small brook flowing into the St. John River a short distance above Belyea's Inn. On one side, and in the bottom of the ravine, the rocks are dark purple slates and green chloritic slates, such as elsewhere occupy a position at the summit of the Coastal group, but which are entirely wanting throughout the Kingston group. The south side of the same ravine presents to view a mass of hard dark grey slates, the lowest beds of the Kingston group visible here, which thence occupy the remaining space as far as Brundage's Point. The strata in this space are similar to those seen about Harding's Point, and along the southern shore of the Long Reach, on the other side of the river. They occupy a more northerly position, but are a part of the same series. **Contact of formations.**

The succession of these Lower Kingston beds, as exhibited along this shore, for the space of three-quarters of a mile, is as follows :—

1. The hard compact dioritic rusty-weathering sediments above noted at the side of the ravine.

Section north of Brundage's Point.

2. Dark grey porphyritic slates, with chloritic scales, dip N. 50° W. < 90°.
3. Grey clay-slates. Dip S. 50 E. < 80°.
4. Grey feldspathic slates, in thick beds, dipping S. 50° E. < 80°.

[These feldspathic beds very closely resemble the strata exposed to view in the gorge of the Magaguadavic River, about half-way from the village of St. George to the river's mouth.]

5. Hard micaceous slate. Dip S. 50° E. < 80°.
6. Grey imperfect gneiss, opposite the south shore of the Reach.
7. Hard grey slate (fossiliferous?)
8. Hard grey feldspathic slates, with grey and white streaks.

From this point (which, on the strike of the beds, is a little south of the Episcopal church) to Brundage's Point, the same slates alternate with beds of flesh-red felsite and dark grey diorite. These are similar to those seen on the opposite side of the river at the Land's End, and with the associated gneissoid beds form the western shore of the river as far south as Brandy Point, but are much obscured by a covering of drift. Below Brandy Point they are followed by a thick series of red sandstones and conglomerates of Lower Carboniferous age, which intervene between them and the Laurentian gneiss of Grand Bay, as do similar deposits about the Milkish Passage on the opposite side of the river.

In addition to the exposures above detailed in the parishes of Westfield and Kingston, in the County of King's, the only points at which we have had occasion to examine the rocks of the Kingston group, are on the Musquash and New Rivers, and about Beaver Harbor in Charlotte County.

Musquash River.

The first named stream, after descending from the granite hills of the Nerepis range, passes through a flat and rolling wooded country, thickly covered with modified drift, which rests upon the slates etc., of the Kingston group. These appear in nearly vertical beds (dip N. < 70°—90°) along the stream, from a point a little below the mouth of Seven-Mile-Lake Brook to the head of Deadwater above Knight's Mills. The first beds visible on the river-side are micaceous slates, with fine dark grey clay-slate. These are followed by dark grey micaceous gneiss and clay-slates, which, as well as the first-named beds, belong to division 1. At McNanley's Brook fine grained schistose diorite and hornblende-schist appear. To these are added, at the lowest exposures, pinkish felsite (division 2.)

East Branch of Musquash.

To Capt. J. P. Robson we are indebted for the following information respecting the occurrence of these rocks on the east branch of Musquash River:—" At the dam on Big Lake (Loch Alva)gneiss occurs; on the stream flowing from Belvidere Lake there is a white pearly micaceous slate (probably the same as that noticed at the Land's End) as well as greenstone (diorite) and transition slate; on the east branch, below Big Lake, are granite and gneiss, with numerous veins of quartz, trap and greenstone," (probably the repetitions of beds of division 3.) " At Nelson's Lake it is principally a trap for-

mation, and on the stream flowing from Deer Lake, granite rock, with beds of trap" (diorite and gneiss.)

The following description of the Kingston rocks, as seen upon New River in Charlotte County, is taken from an Appendix (by Mr. Matthew) to our "Observations on the Geology of Southern New Brunswick." An examination of this stream was made "from its mouth to a point eight miles inland, and the strata found to consist chiefly of schistose gneiss, passing on the one hand into hornblende-schist, and on the other into slaty compact feldspar, or more rarely into mica-schist. These are in frequent alternating beds. Hard clay-slate, cherty slate and silicious mica-slate are of less frequent occurrence. At the river's mouth the strata are somewhat chloritic, and towards the interior the stratification of the gneissoid beds becomes more obscure, and ridges or beds of syenite and granite appear. These granitoid rocks are probably altered sandstones and grits, for at a cliff on the east side of the stream a bed of granite, two or three feet thick, was seen resting upon slate, and overlaid by similar schistose beds obliquely laminated. The inclination of the beds is S. S. E. $< 40°—60°$. There is a fold in the strata a short distance below the Falls, but the thickness of the beds must nevertheless be great." New River.

To this description we have little to add, except to say that the ledges from the post-road southward towards Mace's Bay pertain to divisions 3 and 4, and that division 2 is clearly distinguishable at the Falls one mile above the road. In the next mile there are few exposures, but among them is one, a little above the Falls, of dark porphyritic slaty felsite, with grains of quartz, grey clay-slate and dark diorite, indicating a passage to division 1. The dip is S. $< 60°$. On approaching the strata of the Coastal group further up stream, one meets with ledges of greenish chloritic granitoid rock, with grey clay-slate having elongated amygdaloidal cavities, (dip S. 10° E. $< 50°$.) These are likely to be near the base of the Kingston group. Chlorite and epidote in veins, with orthoclase, characterize the rocks of this series at New River, as at the Land's End and Kingston. Chlorite and epidote.

eaverHarbor

The Kingston rocks as seen on the two sides of Beaver Harbor, consist of greenish-grey and dark grey schistose diorite, dark mica-schist, grey gneiss, and grey and pink felsites. On the west side of the harbor they enclose veins of calcite, epidote and quartz, and scattered nodules of copper-pyrites. On the east side they dip S. 70° E., and on the west side S. 60° E. at an angle of 70°. These beds are all of division 3. On the south they are bordered by sediments of the Coastal group, and on the north by black shales and quartzites resembling those of the St. John group. They are only a mile in breadth where they disappear beneath the waters of the Bay of Fundy.

We pass now to a consideration of the second belt of Kingston rocks, exposed in the Mascarene peninsula and the Western Isles.

At the extremity of Back Bay road, which runs along the south side of the peninsula in question, there is a low point of Upper Silurian shales. Just

La Tete.

westward of this, on the southern face of La Tète Head, the beds are schistose chloritic rocks, varying from chloritic schist to grey slate on the one hand, and to grey chloritic diorite on the other. They include also some greenish micaceous slates; these slates, and some of the diorites, being full of irregularly lenticular cavities on weathered surfaces. At the top of the cliff these beds are met by hard shales and grey conglomerates with slate pebbles. These beds (which are of the Kingston group), are nearly perpendicular, and have a strike varying from S. 60° W. to N. 80° W. On the north side of them, and still on the top of the Head, are porphyritic dark grey diorite and grey felsite, underlaid by hard fine grained dark grey sandstone and hard dark grey sandy shales inclining S. 30° E. < 70°. In the hollow at Mill

Mill Cove.

Cove, lower beds come into view. They are hard dark grey fissile shales, alternating with hard dioritic beds, dipping S. 20° E. < 60°. At this point there is a fault running in a northeasterly direction, by which the measures are let down on the north side many hundred feet. Northward of this fault is a belt of softer slaty rocks, apparently of Upper Silurian age, which occupies the shore as far as the beach which connects the more northerly of three islets which lie to the westward of this cove. Beyond this beach, the older rocks come again to the surface. They are dark grey felsite and schistose diorite, a repetition of the beds seen on the Head. Some of these imperfect diorites are epidotic and amygdaloidal, the amygdules varying in form from globular to lenticular, while some are concavo-convex. The greater number of these do not exceed half an inch in diameter, but a few attain a size of from one and a quarter to one and a half inches.

Woodward's Mine.

On the hill near Woodward's copper mine, is a mass of coarse slaty conglomerate, with rounded fragments of hard grey slate, quartzite, etc., similar to that on La Téte Head. This is followed, going northward, at the mine, by amygdaloidal and compact diorite, alternating with beds of dark fissile shales, similar to those of Mill Cove above noticed. These shales are followed by measures which are mostly obscured by surface-deposits, but of which a few beds are exposed on the beach north of the mine. They are schistose greenish diorites, with beds of clay-slate, grey felsite and felsite-conglomerate. Here the rocks of the Kingston group are met by a mass of dark purple feldspar-porphyry like those of the Coldbrook group.

It has been stated that the northeastward extension of the above named Kingston rocks probably lies in a sharp synclinal fold. This conclusion is suggested by the fact that the black and dark grey fissile slates of division 2 appear on both sides—viz.: at the Magaguadavic Falls, and on the north side of L'Etang Harbor, the interval being occupied mostly by hardened shales, amygdaloidal, porphyritic and compact diorites (part of which are intrusive), some grey conglomerate, reddish-grey felsite, and a coarsely crystalline

rock consisting of feldspar, hornblende and epidote. The strike of the slates here is more nearly east and west than at La Tête Head.

The lowest beds of the Kingston group exposed in the estuary of the Magaguadavic River, may be seen about half-way from the village of St. George to the harbor at the mouth. Here, on the west side of a little promontory near McLeod's mill-stream, and in the cliff along the river-side above, are Magaguadavic River.

a. Black shales, succeeded by grey slaty felsites, alternating with two or three bands of black clay-slate.

b. Grey felsites, some of which are porphyritic and amygdaloidal, alternating with dark grey clay-slates.

c. Vesicular diorite and dioritic slate, alternating with fissile black slates. [These are the same as the slates seen at the town of St. George and at Woodward's mine.]

The series exposed in this bluff is about a quarter of a mile wide, and the beds dip south-west at a high angle.

The Kingston rocks described above in the Mascarene peninsula are separated from those of the Western Isles by the waters of La Tête Passage. La Tete Passage. In the latter are several small islands, of which the largest are Great La Tête (or McMaster's) and Doyle's (or Pendleton's) Island. We have examined neither of these over their entire extent, but on the northern and eastern side of the former are high bluffs of red-weathering felsite, probably of the Coldbrook group; on the latter the only rocks visible in passing along its northern side are red conglomerates and sandstones resembling those of the Lower Carboniferous formation.

The structure of Deer Island, the largest island in the chain under Deer Island consideration—having an extreme length of about seven, and a breadth of from one to three miles—is essentially the same (at least at its eastern end) with that of the Mascarene peninsula about La Tête, but with some differences of detail, as shown in the following notes :—

On entering the island at its northern end, where a small strait (Doyle's Passage) separates it from Pendleton's Island, the first rocks seen along the shore are hard greenish-grey and grey slates and slaty conglomerates, associated with black slate, dipping S. 10° E. $<$ 70°. These are followed by reddish shale, black slates, and porphyritic felsite, the latter passing into feldspathic slate. The surface-breadth of these beds is about 300 feet, beyond which are sixty feet of greenish-grey grit and conglomerate, dipping S. $<$ 60°, which are partly porphyritic and amygdaloidal. To these succeed silicious beds with quartz veins, dark slate (mostly in fine beds, but alternating with others which are more coarse), green and purple shales, and conglomerates with slaty fragments. Irregularly bedded black shales, which are pebbly and very ferruginous, intervene between these and greenish-grey amygdaloidal shales. The latter dip S. $<$ 70°, passing into a conglomerate of the same

color. These are again followed by black slates alternately coarse and fine, probably the same as those first noticed, repeated by faulting. Some of these beds may be of Upper Silurian or Devonian age, but the bulk of the sediments here exposed are the same as those about Woodward's mine on the Mascarene shore.

The rocks last named are succeeded on the southern side by very ferruginous grey feldspathic rocks, with grey and greenish-grey micaceous and chloritic schists in thick beds, with thinner beds of dark grey color, dipping S. 20° E < 70°. These slates are sometimes amygdaloidal, and contain boulders or concretionary masses which give to the rock the aspect of a conglomerate. They are associated with schistose diorite, and are probably the same as those about La Téte Head. Similar schistose diorite, with beds of hornblende-slate and grey clay-slate form high hills at the eastern extremity of the island.

Passing over these dioritic rocks to the southern side of the island, the following rocks are met with along the shore from opposite Jameson's Island to the cove above Hardwood Island:—

Section near Hardwood Island.

Coarse grey slate and greenish-grey amygdaloidal slate. Dip. S. 40° E. < 70°.
Rusty black slate, above the last, but nearly vertical.
Grey amygdaloidal shales, the lower portion with pebbles of black slate.
Grey and dark grey shales and felsite, with diorite.
Black and very lustrous slates, in thick beds.
Greenish-grey chloritic schists. Dip S. 20° E. < 70°.
Hard grey banded ferruginous slates, which are crumpled, and hold veins of quartz.
Greenish-grey amygdaloidal slates, holding black slate pebbles at the base.

The dip of the last named beds is northerly, and they probably correspond to the similar beds in the beginning of the series, re-appearing by a fold. Numerous smaller folds and faults may also be distinguished, the general dip being southerly.

Hardwood Island.

Near this point a small island, known as Hardwood Island, is separated from Deer Island by a narrow tidal passage, and on its shores exhibits a continuation of the series under consideration. At its western extremity the beds are similar to those on the neighboring shore of Deer Island, consisting of greenish-grey and grey shales, hard grey slates and black fissile slates, the first named beds being much corrugated in small sharp folds, and containing quartz veins, some of which hold variegated copper ore. The general dip is southerly < 60°, in which direction they are followed by thick beds of feldspathic quartzite, and greenish-grey feldspathic shales, the dip being as before, but more nearly vertical. These grey shales are associated with others approaching to black in color, and containing elongated feldspathic pebbles. With some reddish felsite and beds of dioritic slate and diorite, they extend to the eastern end of the island. The rocks seen on this island are probably the same as those about Back Bay on the La Téte shore.

From Stewart's Creek, which separates Hardwood Island from Deer Island, the shore of the latter coincides roughly with the strike of the beds, which, with features similar to those above given, extend to Lord's Cove. **Lord's Cove** The northeast side of this cove is composed almost wholly of felsite, but at its head are grey slate-conglomerates, nearly vertical, and behind these along the road, black and dark grey slates, dipping southerly at a high angle. On the western side of the cove the grey slates and felsites re-appear, dipping S. 30° E. < 70°, and extend across the peninsula which intervenes between the latter and Northwest Harbor, separated, however, on their seaward side from other felsites by heavy beds of diorite. Similar diorite beds, some of which are very coarse, with large separate crystals of pink feldspar and hornblende, re-appear also on the northern side of the slates last mentioned, rising into ridges for three-fourths of a mile along the road between Northwest and Northern Harbors.

In passing across the island between these two indentations, the diorites in question were found to be succeeded on their northern side, half-way between the harbors named, by nearly vertical grey slates, dipping N. 50° W < 90°, They are similar to those seen at the eastern end of the island, and, with the diorites to the south, appear to traverse the central portion of the island through its entire length, being probably, as at La Téte, thrown into a sharp synclinal fold, flanked on either side by amygdaloidal shales, black slates and felsites, similar to those of Hardwood Island. **Synclinal.**

Beds of this character were observed along the western shore of Northern Harbor, and in the peninsula between the latter and Clam Cove, terminating in Clam Cove Head. **Northern Harbor.** Where the main road passes the more westerly of the two coves which form the head of the first named harbor, are soft dark slates and porphyritic felsites, followed on the north by grey slaty conglomerates, similar to those seen at the eastern end of the island, and dark grey slates, both dipping north-west at an angle of 80°, which gradually declines to 60°. These, and greenish-gray shales, may be seen as far as the settlement midway between the head and mouth of the harbor, but here the dip is nearly west, at an angle of 60°.

Between this point and the settlement of Clam Cove, the rocks are porphyritic felsites, with some conglomerate, resembling some members of the Mascarene series, and here perhaps overlying the older rocks under consideration. **Clam Clove.** Near the middle of the Clam Cove Settlement these are followed by greenish-grey amygdaloidal shales, some portions of which alternate with thin layers of black slate, while others hold numerous irregular fragments of the same. Their dip is S. 70° W. < 70°. The arrangement of the beds in this vicinity is such as to indicate the existence of a fold, the axis of which has a course nearly north and south, for in passing westward across the peninsula terminating in Clam Cove Head a series of beds is met with which are apparently a repetition of those observed between this cove and the head of

Clam Cove Head.

Northern Harbor. At the head of the former, and continued in a valley which extends across the neck of the peninsula towards the harbor last named, is a thick series of soft black slates, having on their eastern side feldspathic slates and hard grey laminated felsites, dipping W. $<70°$, with considerable masses of diorite, and on the west other felsites (or a repetition of the same), running out towards Passamaquoddy Bay. Still further west, are hard and coarse grey, often rusty conglomerates, dipping westerly, and holding rounded pebbles of greenish-grey slate, feldspar-porphyry, etc. in a greenish-grey paste. Both the felsites and conglomerates seem to be repeated by faulting, the latter forming the southern extremity of the head, where they are laminated, porphyritic, and of a light grey color, while the former are on the inner side looking towards Clam Cove Settlement. The high bold shore, which on the outer side overlooks the passage between Deer Island and the coast of Maine, is composed of hard grey slates, the strike of the beds being the same as that of the passage, or north and south, and the dip nearly vertical. The black slates are probably the same as those noted at the head of Northern Harbor, and both they and the associated shales, conglomerates, and felsites, equivalent to those seen at the northeast corner of the island, and again repeated on its southern side about Hardwood Island. It is from these black shales that the harbor of Clam Cove and its extension in the valley northward has been excavated, its western shore being composed of the more resisting beds, which, with a nearly southerly course, have probably determined also the triangular form of the island itself.

Cumming's Cove.

From Clam Cove to Cumming's Cove the shore has not been seen, but at the southern extremity of the former, and for some distance southward, outcrops of diorite are frequent, and are followed on the north side of the last named cove by ridges of grey felsite. On the eastern side of Cumming's Cove are grey feldspathic slates, (weathering pale grey) and hard grey sandy shales, which, with thinner beds of grey slaty conglomerate and feldspathic quartzite, make up the bulk of the peninsula running out to Deer Island Point, and forming the ridge by which the last mentioned cove is separated from that of Mill Creek. The dip of these beds is E. $< 70°$. The northern side of the last named indentation shews a succession of dark grey and grey shales, greenish-grey sandy shales (with green chloritic spots) overlaid by fine black slates; also, fine grained banded liver-grey slates, with thinner beds of hard grey pyritous sandstone and diorite. The dip is very variable, and the whole series exibits a succession of small plications.

Charlotte Cove.

The beds above mentioned are probably a continuation of those seen along the southern shore of Deer Island at its eastern end (near Hardwood Island.) They form the ridge between Mill Creek and Chocolate Cove, and are well exposed near the latter, consisting of green and black shales, dark grey shales, and dark compact slate (portions of which hold rounded pebbles),

the whole much twisted and folded. The dip on the west side of the last named cove is N. 70° W. < 60°.

Between Deer Island and Campo Bello Island, a chain comprising numerous small islands runs parallel to the former from La Tête Harbor nearly to the town of Eastport. These are extremely various in the features which they present, but so far as they have been examined appear to belong to the Coastal group rather than to that now under consideration, and have been already more particularly referred to in connection with the latter. In the Island of Campo Bello deposits similar to those of Deer Island are again met with, and like the latter probably belong to the Kingston group. This island,—the largest, excepting Grand Manan, along the southern coast of New Brunswick, - has an extreme length of about ten and a average width of about three miles, being separated through its eastern half by Head Harbor Passage and Friar's Roads from Moose Island and the Western Isles, but approaching closely to the mainland at Lubec and the West Quoddy Passage. The southern side of the island being for the most part inaccessible except by water, the following notes relate chiefly to the more settled portions about Wilson's Beach, Harbor de L'Outre and the northwest shore as far as Lubec. **Campo Bello.**

The northeast extremity of the island is a peninsular ridge, the course of which, coinciding with that of the rocks which compose it, is S. 60° W. These rocks on the north side, at Wilson's Beach, are slates and hornblende-rock, and on the southern, where they overlook the deep indentation of Head Harbor Cove, feldspathic slates and diorites, both with irregular dips, but usually inclined at a high angle. This cove has been channelled out from softer slaty beds, some of which may be seen at its head, and again where the road passes the corresponding indentation on the western side of the island. At this point they consist of grey and black slates, having a regular dip S. 20° E. < 80°. Similar beds compose a part of the promontory which bounds this cove upon the south, and are again succeeded by harder slates and hornblendic rocks, which also form a part of the high ridge that separates Head Harbor Cove from Mild Cove. **Wilson's Beach.**

Both of these belts extend across the mouth of Harbor de l'Outre, the softer beds (grey and black shales) appearing along the beach looking towards the main ship-channel, which has probably been partly excavated from them, while the harder rocks rise into bare ridges and knolls, forming much of the promontory which separates Harbor de l'Outre from the Friar's Roads. Though much of this hornblendic rock approaches diorite in aspect and composition, it is nevertheless generally schistose, and more or less amygdaloidial or vesicular, and alternates with thinner bands of grey slates and dark grey felsites. **Harbor de l'Outre.** **Diorites**

Along the shore overlooking the town of Eastport, grey sandy shales come into view, and alternate with grey conglomerates and hard fine grained

dark grey and black slates, pebbles similar to these latter being often enclosed in the coarser beds. Some of the slates exhibit bandings of grey and dark grey colors. Their dip is S. 70° E. < 80°. Farther back upon the hills the dioritic rocks re-appear, and, with hard grey sandstones, grey slates and grey amygdaloidal diorite, extend to the harbor of Welshpool. These rocks are sometimes epidotic, and are traversed by veins of quartz and calc-spar, in two of which shafts have been sunk, and from which ore has been removed to a limited extent, consisting of a mixture of pyrrhotine, copper-pyrites and galena.

Metallic Ores. Welshpool.

The greater part of the village of Welshpool rests upon the compact and schistose diorites and grey sandstones just mentioned, but included among these latter near the Episcopal church, are beds of greenish-grey amygdaloidal diorite and reddish-brown felsite. This last named rock is somewhat crystalline, but mostly fine grained, consisting of red feldspar with a good deal of soft hornblendic matter, but with little or no quartz. The relations of these fine grained felsites and diorites to the more coarsely crystalline masses which enclose them on either side, are very obscure, but judging from their local character and their resemblance to some of the beds of the Mascarene series near the town of Eastport and elsewhere, they would appear to be portions of an overlying series here contained in depressions of the older rock. The beds in question cover but little space, and in approaching the head of Harbor de l'Outre, which here penetrates quite to the village of Welshpool, the dioritic rocks are again met with, associated as before with hard grey shales. These rocks may be seen at many points about the shores of the first named harbor, and upon its eastern side rise into hills of considerable elevation. The diorites, which are sometimes coarsely crystalline and contain disseminated grains of magnetic oxide of iron, are at some points associated with granitoid rocks of light color, containing feldspar and mica. Such is the case near the eminence known as Bunker Hill, about three miles east of the head of the harbor, the eminence itself being composed of hard grey shales, with some conglomerate and grey felsite, the dip or cleavage of the shales being S. 30° E. < 80°. Similar rocks appear in a small peninsula on the eastern side of the same indentation, which at its head is filled with deposits of marine clay.

Bunker Hill.

In crossing the centre of the island from the head of Harbor de l'Outre to its eastern shore at Herring Cove, a distance of one and a half miles, the land is flat, wooded and without rock-exposures, but on either side of the last named cove the strata are again disclosed, and present characters somewhat different from those seen in other parts of the island. On the eastern side of this cove, the beds in question consist of hard slates of alternating grey and dark grey colors, interstratified with grey felsite, feldspathic quartzite and diorite, the whole series dipping N. 50° W. < 40°, but with many minor flexures. Beyond these beds, towards the bay, are dark grey felsites,

Herring Cove.

some portions of which are much stained with iron, and contain scattered nodules of pyrites, while much of the rock is vesicular, the cavities (which are sometimes two inches or more in length), being filled with calc-spar. This amygdaloidal felsite is traversed by thin bands of black slate, which exhibit many sharp angular corrugations and changes of direction, while more rarely, pebbles of the same are enclosed in the feldspathic mass. The slates seen at this point are not unlike some of those already noted as occurring on the other side of the island. Felsites.

A long pebbly beach forms the shore of Herring Cove to its western extremity, where rocks similar to the above again come into view. This is the most westerly point on the ocean side of the island to which our observations have extended, but on the other or northern side, a few additional notes have been taken between the villiage of Welshpool and the Narrows of Lubec.

No rocks are exposed along the southern shore of the harbor of Welshpool, but at its western extremity rises the bold bluff of the Friar's Head, disclosing at its base rocks similar for the most part to those of Harbor de l'Outre. These consist to a great extent of hornblendic rocks and schistose diorite, but with these are hard grey slates and grey sandy shales and sandstones, having a dip S. 30° E. < 90°. Beyond the head, to the west, the first named rocks are much broken by faults, and enclose large lenticular masses of a pale grey, yellowish-weathering feldspathic rock, studded with grains of quartz. In a small cove (Snug Cove) which intervenes between the Friar's Head and the Narrows, the diorites are cut by dykes containing scales of black mica, and are followed by hard grey and dark grey slates, having a dip N. 40 °W. < 40° Both rocks cross the Narrows and re-appear in the town of Lubec. Friar's Head. Lubec.

The rocks resembling those of the Kingston group on the island of Grand Manan are for the most part confined to its northeastern extremity, between Whale Cove and Spragg's or Petté's Cove. They embrace a considerable thickness of hard grey feldspathic slates, associated with imperfectly crystalline epidotic and chloritic schists, with thin beds of pale red porphyritic felsites. They have already been more particularly described in a preceding section. Grand Manan.

LOWER SILURIAN.

ST. JOHN OR ACADIAN GROUP.

The Huronian rocks of St. John County, as described in the preceding section, may be seen at several points to pass beneath a group of schistose rocks, consisting of grey and dark grey shales, slates and fine grained sandstones, which are in striking contrast to the dioritic and petrosilicious rocks and coarse red sediments upon which they rest. This assemblage of strata, first described under the designation of the St. John group, and for which Dr. Dawson has proposed the name of the Acadian group, was first recognized as distinct from the underlying and overlying sediments near the city of St. John by one of the authors of this Report, in the year 1862; this conclusion being based partly on an apparent unconformability between these latter and those of the St. John group, and partly on the discovery of trilobites in shales near the base of the last named formation. Fossils, chiefly obscure *Lingulæ*, had been observed at a much earlier period by Prof. W. B. Rogers, Drs. Gesner and Robb, and others, but these, as well as the trilobites first obtained, were too imperfect for determination, and it was not until the year 1865 that more perfect collections of these remains, made by the authors in connection with Prof. C. F. Hartt, enabled them to fix with precision the geological horizon of that portion of the series in which they occur. In our Report of that year to the Legislature of the Province, a preliminary notice of the organisms referred to was published by Prof. Hartt, and the horizon of the beds in which they occur pronounced to be Primordial, and equivalent to the Etage C. of Barrande in Bohemia. This conclusion was subsequently confirmed by Mr. Billings, by whom the same beds are compared with the Menevian group beneath the Lingula flags of Great Britain, and considered as more ancient than the Potsdam sandstone of the state of New York. They represent, therefore, a Silurian horizon older than elsewhere recognized on the continent. More recently, detailed descriptions with some illustrations of the organisms in question have been published, from notes by Prof. Hartt, in the second edition of the Acadian Geology of Dr. Dawson.

History.

Age.

The following is a list of the forms so far distinguished, and described in the work referred to:—

Organic remains.

RADIATES.—*Eocystites primævus*, Billings.

MOLLUSCA.—*Lingula Matthewi*, Hartt; *Lingula*, n. sp., Hartt; *Obolella transversa*, Hartt; *Discina Acadica*, Hartt; *Orthis Billingsi*, Hartt; *Orthis*, n. sp., Hartt.

ARTICULATA.—*Conocephalites Baileyi*, Hartt; *C. Matthewi*, Hartt; *C. Robbii*, Hartt; *C. Orestes*, Hartt; *C. elegans*, Har.t; *C. Ouangondianus*, Hartt; *C. tener*, Hartt; *C. Aurora*, Hartt; *C. Thersites*, Hartt; *C. gemini-spinosus*, Hartt; *C. Hallii*, Hartt; *C. quadratus*, Hartt; *C. neglectus*, Hartt; *C. formosus*, Hartt; *Conocephalites*, n. sp., Hartt; *Microdiscus Dawsoni*, Hartt; *Agnostus Acadicus*, Hartt; *A. similis*, Hartt; *Paradoxides lamellatus*, Hartt; *Paradoxides Micmac*, Hartt, figured, but not described.

The apparent thickness of the whole formation, as measured in the city of St. John, is about 4,500 feet. The actual thickness, however, may be much less than this, for while there are numerous faults and folds for which allowance is made in the above estimate, a repetition of similar sediments on either side of the trough of these rocks upon which the city of St. John stands, would appear to indicate that the entire series, with the underlying Huronian strata, is here folded upon itself in a sharp synclinal, overturned to the northwest. In this case, the aggregate thickness of the series, exclusive of the lower red beds—which are what has been called Upper Coldbrook—will not much exceed 2,000 feet. **Thickness.** **Overturn.**

The rocks of the St. John group have been recognized in a number of valleys traversing the hill-country of southern New Brunswick. The most southern of these depressions is that extending through from the city of St. John by way of the Loch Lomond lakes to Hammond River; the second is the valley of Kennebecasis River; the third, the valley of the St. John River in the Long Reach and Belleisle Bay, and lastly the valley of the Nerepis River. Beyond this to the northwest the coal-formation conceals all inequalities in the surface-features of the older formations. In Charlotte County, slates, shales, etc., resembling those of the St. John group, may be seen in such depressions as Oak Bay and Beaver Harbor, and those at the mouth of the Magaguadavic and L'Etang Rivers. In the first named basin they lie between the mica-schists and fine grained gneisses of the district about St. Stephen and a band of coarse conglomerates of uncertain age; in the localities last named they lie next the Kingston group. **Distribution.**

No useful minerals or economic products have as yet been observed in the rocks of this formation.

DETAILS OF THE ST. JOHN OR ACADIAN GROUP.

St. John Group in St. John County.

The most complete view of the rocks of this group is that afforded in and about the city of St. John, where it was first studied. This city stands upon the southern and principal one of the belts to which reference has been made, and which has thence been traced both to the east and west of the St. John River, in the former direction for a distance of nearly

Relations to Coldbrook group.

thirty miles, and in the latter for probably twelve or more. In both cases the rocks of this group rest upon red beds described in our report to the New Brunswick Legislature as the Upper Coldbrook strata; with which near St. John, they are conformable, and from which they are separated by a band of hard grey sandstone and coarse grey arenaceous shale, which apparently constitute beds of passage between the two.

Carleton.

In the town of Carleton, a suburb of the city of St. John, the beds of this series form a portion of the shore of the St. John River below the Suspension Bridge. They have here a surface-breadth of no great extent, and are included, at the Falls, between a narrow belt of Coldbrook rocks and the great mass of dioritic and slaty rocks which appear a short distance southward. These are now thought to be the same Huronian rocks re-appearing from beneath the St. John group and overturned upon it. A similar relation exists between these same two formations both to the west and east of the locality under consideration.

Overturn.

In the former direction a band of dark crumbling and pyritous slates has already been alluded to as extending through the peninsula of Pisarinco to Black Beach near the mouth of Musquash Harbor, and as nearly resembling those at the base of the St. John group. They rest against limestones supposed to belong to the Laurentian system, and are overlaid by schists of greenish-grey color, both having a southerly dip of 40°. The latter we suppose to be of Huronian age.

Musquash Harbor.

To the eastward, these two formations may again be seen with the same relative position in the city of St. John, but here the breadth of the St. John group is greatly increased, underlying the entire city with the exception of two streets at its southern end. On the north, beyond the European and North American railway, the base of the group, consisting of soft grey highly fossiliferous shales, grey sandstones, and coarse silicious shales, may be seen to rest upon greenish petrosilicious rocks of the Coldbrook group, which, between this point and Lily Lake, intervene between the Primordial and the Laurentian series. The following section, representing the characters and relations of the succeeding beds, is quoted from Mr. Matthew's paper "On the Azoic and Palæozoic Rocks of Southern New Brunswick":—

City of St. John.

Section in St. John city.

	FEET.	FEET.
1 *a*. Grey sandstone or quartzite.	50	
b. Coarse grey arenaceous shale		
c. Grey argillaceous shale, rich in fossils; *Paradoxides, Conocephalites, Orthisina, Obolella*		
d. Black carbonaceous shale, full of fossils; *Paradoxides, Conocephalites, Orthisina, Discina, Orthoceras*, and a thin sub-triangular shell, resembling *Theca*, all much distorted...	150	
	——	200

2 *a*. Dark grey shales, with thin seams of grey sandstone ...	220	
b. Coarser grey shales, with grey flagstones	200	
c. Grey sandstone and coarse shales, *Lingula*, etc	130	
	——	550
3 *a*. Dark grey shales, finely laminated	450	
b. Black carbonaceous and dark grey argillaceous shales, more compact than the last	300	
	——	750
4. Shales and flags, resembling 2 *a* and *b*		800 (?)
5. Black carbonaceous shales, resembling 3 *b*, but finer and softer...		450
6 *a*. Shales and flags like 2 *a* and *b*; *Lingula*, a Conchifer, coprolites, worm-burrows, and crustacean markings ...		700 (?)
b. Grey and ferruginous sandstones and beds of coarse slate;		1,100
Lingula		400
7. Black carbonaceous shales finely laminated		650
		5,600

N.B.—The beds here denominated "grey and dark grey shales" are imperfectly laminated clay-slates.

All the rocks of the above section, with the exception of those of No. 7, which occur only on the eastern side of Courtnay Bay, may be seen within the city-limits, and are followed on the south, towards the harbor, by fossiliferous Devonian sandstones and shales. A few dioritic and schistose beds, similar to those of Carleton, of Huronian age, intervene between the two. The apparent thickness of the series is considerably greater than given in the section, but it is supposed that this is increased by faulting or folding, there being numerous minor displacements and plications, while occasionally portions of considerable thickness appear to have been thus repeated. Such is apparently the case with Nos. 4 and 6*a* of the section, and may be true of other members. Indeed there is reason to believe that a large portion, if not the whole, of the St. John group is here folded upon itself, this inversion involving also the underlying Huronian or Coldbrook rocks. Relations to Huronian and Devonian.

At Race Horse Point, on the shore of Courtnay Bay, near the line of section given above, the Devonian (Dadoxylon) sandstones are separated by a space of one hundred feet of sand-beach from dioritic beds which directly underlie about a dozen feet of red conglomerate and slate, but are separated from the red rock by a fault. To these diorites succeeds a series of dioritic and slaty rocks such as appear on the opposite side of the bay within the city limits. The beds next the St. John group are coarse reddish sandy shales, with large spangles of grey mica, exactly like beds holding a similar relation to the St. John group northward of the city of St. John. A fault or crushing of the beds occurs at this point. The St. John slates or shales here are carbonaceous, and have irregularly intercalated and broken silicious and carbonaceous beds. In the latter have been found obscure remains of trilobites, Courtnay Bay. Fault.

apparently fragments of the genus *Paradoxides.* The beds are underlaid on the north by a thick body of fine papyraceous shales, vastly thicker than the black carbonaceous shales (No. 1 *d*) above the trilobite beds on the north side of the St. John slates, but not more so than the fine shales to be presently described, which occur a few miles east at Ratcliffe's millstream, holding the same position in relation to the fossiliferous beds as do those of Courtnay Bay. Markings on the beds beyond the papyraceous shales to the northward indicate that they are overturned.

Probable overturn.

The evidence furnished by the beds here exposed indicates that on this side of Courtnay Bay is a series of strata half a mile wide which has been wholly overturned. It may be remarked, however, that there is here nothing to represent the white quartzite and overlying grey shale, which on the north side of St. John intervene between the trilobite beds and the Huronian rocks, but which pass into a slaty conglomerate one mile west. These quartzites may be concealed from view by the fault which brings the trilobite beds directly against the green and red beds which appear to overlie them. If the above view of the structure of this group in the area where it is best known be correct—namely, that it is reversed upon itself in a deep and sharp synclinal fold—its thickness will be greatly reduced, the same beds being repeated on either side of the axis of the fold. No. 7 will in this case be the same as No. 1 *c* and *d*, and No. 2 will correspond, in part at least, with No. 6. It may be added that this reversal accords with what is seen of the St. John and Huronian rocks at several points farther east.

Between Courtnay Bay and Loch Lomond the rocks of the St. John group appear at intervals along the bottom and sides of the Marsh Creek valley and in that of Little River, differing from their development at St. John principally in the marked diminution of the thick beds of fine sandstone which add so much to the bulk and firmness of the series as seen in that city. On the Coldbrook stream a section of the basal (fossiliferous) portion is well exposed, but the fossils are not so well preserved here as at St. John, and along the hills which intervene between that city and the stream in question. From these hills and from Coldbrook the following species have been collected, and have been described by Prof. Hartt in the second edition of the "Acadian Geology":—

Fossils from St. John and Coldbrook.

Lingula Matthewi, Hartt; *Obolella transversa*, Hartt; *Conocephalites Matthewi*, Hartt; *C. tener*, Hartt; *C. quadratus*, Hartt (rare); *C. neglectus*, Hartt (very rare); *Microdiscus Dawsoni*, Hartt (abundant); *Paradoxides camellatus*, Hartt; *P. Micmac*, Hartt.

Loch Lomond.

Along the southern shore of Loch Lomond the rocks of the St. John group are mostly concealed from view, though indicated by numerous fossil-bearing fragments in the soil, but a short distance southeast they may be seen on the Quaco road, and are well exposed in the valley of Ratcliffe's

Millstream. At this point they exhibit the following succession of inverted beds :—

Fine black slaty shales, dip S.50° In the same beds there is an abnormal strike of S. 65° E. The true strike N. 85 E. is resumed further northward, with a dip of 80° southerly. Succession at Ratcliffe's Millstream.

Grey shales, holding the following species of trilobites and brachiopods : *Lingula*, n. sp. Hartt ; *Discina Acadica*, Hartt ; *Orthis Billingsi*, Hartt ; *Conocephalites Baileyi*, Hartt ; *C. Matthewi*, Hartt ; *C. Robbii*, Hartt ; *C. Orestes*, Hartt ; *C. elegans*, Hartt ; *C. Ouangondianus*, Hartt ; *C. Aurora*, Hartt, (rare) ; *C. Thersites*, Hartt, (very rare) ; *C. Hallii*, Hartt, (not common) ; *C. formosus*, Hartt ; *Conocephalites*, n. sp. (?,) Hartt, (very rare) ; *Agnostus similis*, Hartt, (somewhat rare) ; *Paradoxides* (?) Fossils.

Coarse grey shale and hard grey sandstone.

Greenish-grey, purplish and red shales and sandstones, with a bed of conglomerate

The beds last mentioned and the fossiliferous strata are nearly vertical, (dip. S. < 85°). The relations of the rocks at this point indicate an overturn of both formations, the St. John strata occupying between this point and Loch Lomond the axis of a compressed synclinal. By the same compression and accompanying dislocation, these strata are again repeated farther south; for at the Negro Settlement a second belt of Primordial rocks has been observed resting, as before, upon the Coldbrook group, and dipping towards the Coldbrook rocks of Bloomsbury Mountain. This second belt is narrow and of limited extent, being apparently confined to the valley of Black River. It does not appear on the Quaco road a few miles to the east, the position which it should occupy being covered with Carboniferous deposits. Overturn. Black River.

The main belt of St. John rocks, skirting the southern shore of the Loch Lomond lakes, extends to the eastward with a nearly uniform width. Between the lakes alluded to and the south-west corner of the parish of Upham, the country has not been explored. On entering this parish, however, near where Hanford and Harding's Brooks join the main branch of Hammond River, the St. John rocks are again well exposed in the bed of these streams. On that first mentioned, the slates of the group are separated from the red Upper Coldbrook rocks described in the last section, by beds of white sandstone occupying a position similar to that of Ratcliffe's Stream, but associated with beds of diorite, the whole dipping northerly at an angle of 46°. On Harding's Brook appear the papyraceous shales, of a dark color, with beds of sandstone; but the fossiliferous strata are covered by beds of sand and gravel. The apparent width of the belt at this point is about one and a half miles. It is overlaid on the north by red sandstones of the Lower Carboniferous Period. Hammond River.

We have not observed any outcrops of the St. John rocks eastward of those above noticed, the places which they should occupy in the parish of Hammond being filled with carboniferous sediments.

Strata supposed to be a continuation of those of the St. John group have been referred to in the preceding chapter as extending through the peninsula of Pisarinco to Musquash Harbor. They are well exposed at Mill Creek in Pisarinco Harbor, and again on the opposite side of the peninsula at Black Beach, near the mouth of Musquash Harbor. They in both cases consist of black graphitic, somewhat pyritous crumbling shales, having a southerly dip, and overlaid by greenish-grey slates which are supposed to be overturned strata of the Coldbrook group.

Pisarinco.

St. John Group in the Kennebecasis Valley.

Kennebecasis.

Rocks of this group occur upon the shores and about the islands of Kennebecasis Bay, and point to the existence of a belt of these sediments in this depression similar to that just noticed on the south side of the Laurentian and Huronian area. They are however greatly eroded, and their limits and relations are not yet fully understood.

The most interesting exposure within this region is to be seen on the south shore of the Bay, at Drury's Cove, about five miles northeast of the city of St. John. There is here presented the following succession, which, if the series be not overturned, is an ascending one :—

Succession at Drury's Cove.

1. Grey sandy shales, with two varieties of *Palæophycus.*
2. Sandy shales, fine grey shales and dark flinty beds with trilobites &c.
3. Coarse greenish and reddish-grey syenite. In the lower portion of this mass, especially where it adjoins the slates, it contains small rounded and angular pebbles of quartz and slate.

Fossils.

Mr. Billings has examined the fossils above referred to, and has recognized the following genera, pronouncing the rocks in which they occur to belong to the Primordial series, and most probably to the St. John group; viz: fragments of *Paradoxides* and the pygidium of an *Agnostus* from the black slates of No. 2; and from a calcareous band occurring in the same, three species of *Conocephalites*, one of *Ellipsocephalus*, one of *Agnostus*, and what appears to be a fragment of *Salterella.*

These fossiliferous beds appear to be overlaid by the syenitic rock of No. 3. We know, however, of no similar mass in the Primordial series at St. John, or elsewhere in the belt of these rocks south of the Laurentian area which intervenes between that city and the Kennebecasis, and think that this overlying mass of syenite may pertain to the Laurentian system, to some portions of which it bears close resemblance.

Rocks similar to those of Drury's Cove re-appear at Sand Point, six miles to the southwest, and again at a few points on the north side of Kennebecasis Bay. On Kennebecasis Island, just inside the Milkish Passage, grey sandy shales, filled with impressions of *Palæophycus* of two or three kinds, rest upon reddish and greenish-grey Laurentian gneiss. They have

Kennebecasis Island.

a northerly dip and are overlaid by red-brown conglomerates of Lower Carboniferous age. Towards the upper end of Long Island also, along its southern shore, are thinly laminated grey shales with thin layers of fine sandstone much contorted, apparently resting upon crystalline limestone and granitic gneiss, and dipping northwest at an angle of from 60° to 70°. In the shales occur fragments of a *Lingula* similar to that found in the St. John beds, as well as numbers of worm-burrows and other markings. Long Island. Fossils.

It is worthy of note that no trace of the vast mass of Huronian strata underlying the St. John group in the county of that name, has been observed in connection with these Primordial rocks.

St. John Group in Northern King's County.

The Primordial strata which occur in the Long Reach of the St. John River, like those of the Kennebecasis Bay, have suffered greatly from erosion, and are now found in outcrops of very limited extent. The only point in this valley in which beds of this age have been identified by fossils is a small island, known as Caton's Island, lying off the mouth of Jones's Creek, and about two miles below the promontory of Oak Point. The beds exposed here are the following:— Long Reach.

Pale grey sandstones, in thick beds, somewhat rusty and covered with spangles of mica; dip N.10° E. < 40°. Section at Caton's Island.

Grey sandy shales.

Hard bluish-grey calcareous beds or impure limestones, the beds about four feet in thickness, alternating with soft dark grey shales, which are somewhat carbonaceous and contain black lustrous films. Dip N. 20° E. < 60°.

From the last named beds the following fossils, determined by Mr. Billings, were collected :—A cylindrical stem, three lines in diameter, two inches long, transversely wrinkled or annulated, evidently one of those forms usually referred to *Palæophycus* ; *Conocephalites Matthewi* ; *C. Robbii*, *Paradoxides*, undetermined ; *Orthis*, n. sp. ; together with fragments of several other species. Fossils.

The rocks of Caton's Island are separated by a channel of no great width from the north shore of the Reach, upon which the nearest beds are purple shales and conglomerates, overlaid by grey fissile shales, described in a preceding chapter in connection with the Coastal group. Their dip is S. < 40°.

The only beds additional to those of Caton's Island met with in the great depression under consideration, which we think may be of Primordial age, are certain rusty dark colored and somewhat plumbaginous shales found about Tenant's Cove above the head of the Reach, and thence apparently extending to Jenkin's Cove on the north side of Belleisle Bay. They are not sufficiently exposed at either point to be certainly identified. Tenant's Cove.

St. John Group in Wickham, Queen's County.

In describing the rocks of the Huronian series in this parish, reference has been made to the occurrence on the eastern bank of the St. John River, near the foot of Long Island, of a mass of dark grey and black shales, which are probably of the St. John group. No fossils have been found in them, but in their soft and thinly bedded character, and in containing much iron pyrites, as well as in their dark color and their relations to the associated strata, they resemble the rocks of this group to be presently noticed on the Nerepis River, north of the granite hills in Queen's County. At the point in question they occupy the greater part of a small valley about a mile below Golding's Landing, having an exposed breadth of somewhat over one hundred yards. They have a southerly dip of 80°, and are included between a mass of grey light-weathering felsites and dioritic rocks on the northern side and green and purplish-red argillites on the south.

Long Island.

Black shales occupying a similar position have been described in the same connection with the above in the northern part of the London Settlement, and others, which may be a portion of the same series, in the northern part of the parish of Springfield. At each of these points they are poorly exposed.

St. John Group in the Nerepis Valley.

Along the northern side of the Huronian (Coldbrook) rocks described in a preceding chapter as crossing the Nerepis River at Armstrong's Corner, there is a narrow strip of shales which are judged to be of the St. John group from their softness and general appearance, and from their immediately succeeding the red and green beds which intervene between them and the Huronian rocks. The most westerly beds noticed are exposed in the river-bank on Armstrong's farm, but their connection with the subjacent strata is more manifest at a locality at the river-side on the farm of Wm. Wood, already noticed in the section on the Huronian rocks. This belt of St. John shales or slates is better seen further up the valley. At the foot of Coot Hill the valley of the Nerepis diverges northward from it, while the shales follow the course of a small stream coming in from the eastward along the southern base of that hill. At the bridge where the Gagetown road crosses this brook there are exposures of grey and dark grey shales in thin alternate seams; they are rusty-weathering and somewhat pyritous and micaceous, and are a good deal contorted. The dip is N. 20° E. $<$ 80°. For a mile upward, along this stream, the strata of the St. John group form rounded slate hills on each side of the stream, and are in some places overturned, dipping S. 10° E. $<$ 70°. These slates are exposed in ledges near a grist-mill, but one-quarter of a mile southward of it, on the Jerusalem road, an overlying deposit of Lower Carboniferous felsite or claystone, of flesh-red and purplish-grey color, conceals the older rocks from view.

Nerrepis.

The strata of the St. John group in this valley contain much iron, mostly in the form of pyrites, which, decomposing, gives the rocks a rusty appearance, and is the source of deposits of bog-iron ore.

St. John Group in Charlotte County.

The rocks which we think may be the representatives of the St. John group at Oak Bay on the St. Croix River, present essentially the same features as those which elsewhere characterize the rocks of the same formation, being mostly soft dark grey or black finely laminated shales, which are somewhat carbonaceous and often pyritous and rusty-weathering, but include also some thin beds which are coarser and more silicious. Where the post-road between St. Andrew and St. Stephens crosses the head of this indentation, these dark colored shales, having a nearly vertical attitude and a northerly course, lie immediately to the westward of and dip slightly beneath a mass of grey feldspathic and silicious rocks, which may be of Upper Silurian age; but to the northward of this point, and again in the opposite direction, on Roger's Island, (a high bluff rising from near the middle of the bay,) there intervene between the same rocks heavy masses of hard grey conglomerate. The relations of this conglomerate are obscure, but on Roger's Island, where the contact of the two rocks is well exposed, the shales dip slightly beneath the conglomerates, contained within which are thin layers of the shales. The shales near the junction of the two also include pebbles similar to those which make up the mass of the coarser rock. The shales upon this island are a good deal folded, but have, nevertheless, a thickness of several hundred feet. Oak Bay.

The rocks of Beaver Harbor and the Magaguadavic and L'Etang Rivers, alluded to as resembling those of the St. John group, have already been described in connection with the Kingston and Coastal rocks of the same regions.

THE MASCARENE SERIES.

Contrast with Huronian.

This remarkable group of sediments is largely developed in the vicinity of Passamaquoddy Bay. In general aspect it resembles the Huronian series of St. John and King's Counties. Diorites and fine grained felsites are common to both, and in each the lower part is marked by the presence of dark grey and black petrosilicious beds. The Mascarene series, however, differs from the resembling group to the eastward in that much of the petrosilicious strata has strongly marked color-bands, a feature which has not been observed in those of the Huronian series. In the latter, also, are great masses of chloritic and micaceous slates with dolomites, strata which have not been recognized in the Mascarene series. Until, therefore, the age of those rocks can be determined we think it best to distinguish them by a local name.

The lower part of the Mascarene series of Passamaquoddy Bay and vicinity is characterized by grey and dark grey colors. The lowest division visible here consists of olive-grey feldspathic shales, followed by grey and dark grey flinty slates, the latter with narrow distinct bands of color. At many points along their northern border they may be seen to rest upon red crystalline felsites, and at others directly upon the intrusive granite. We have found no fossils in these lower petrosilicious beds, but in a series of greenish-grey and purple sandstones with greenish and red clay-slates, which immediately succeed them, shells of the genera *Lingula* and *Modiolopsis* are not uncommon, while on the Magaguadavic River and Mascarene shore, where the same series appears on the other side of a synclinal fold, some of the sandstones are abundantly charged with these and other fossil shells. At each of these points there are in the lower shell-beds vegetable impressions, and at the Mascarene shore some of the darker and finer silicious beds are filled with the remains of comminuted plants, but they have not as yet yielded any determinable species.

Fossils.

More than one half of the Mascarene peninsula is composed of hornblendic rocks, felsites and dark grey slates, described in preceding pages in connection with the Kingston group, which here reaching the coast from the interior, passes into the islands of Passamaquoddy Bay. On the northern side of these slates, however, and a few miles south of Point Midjic, are strata forming the southern border of a basin of rocks belonging to the series now under consideration, which probably underlies the whole of Passamaquoddy Bay. These on the Mascarene shore present the following features :—

Along the beach to the northward of the hill of Kingston rocks which rises up from Woodward's mine, are exposed low ledges of chloritic diorite, slate-conglomerate and hard black shales of uncertain age, but probably connected with the Kingston group, and having a dip of S. 30° E. < 70°. The

beach is terminated by a mass of dark purplish-grey porphyritic felsite, similar to that seen in connection with the Coldbrook group in Queen's and St. John Counties. North of the felsite is a small amount of slate-conglomerate with dark slaty veins, resting upon greenish-grey argillites holding imperfectly preserved shells resembling *Modiolopsis*, and dipping S. 20° E < 70°.

On the north side of Green's Cove there is a bed of black shales, having in connection with it a quartz lode holding some galena, overlaid by greenish-grey argillites similar to those seen on the opposite point. These, at the point on the north side of the cove, are associated with hard red clay-slates and porphyritic red felsite with dioritic beds. After passing a beach, more of these red and grey argillites and sandstones appear, with a dip S. 50° E. < 50°, and extend along the shore for half a mile to McNichol's Cove. On the north side of the cove last named the red argillites dip northerly at an angle of 30°, and are soon overlaid by the red felsites, which run out to the point on the north side of this cove, and are cut off, a short distance up the shore, by a fault, which again brings up the older beds.

The following section, roughly measured by pacing along the shore, will explain the relations of the strata extending northward from this fault, and the position of the fossiliferous layers.

Section on Mascarene shore.

	FEET.
Division 1.	
Hard grey feldspathic slates and olive-grey argillites, including fifty feet of measures concealed	400
Division 2.	
a. Black and dark grey banded silicious beds, the colors in distinct alternating bands from one to three inches thick, with obscure remains of plants	380
b. Similar beds, but paler in color, with a little conglomerate, holding, about the middle of the mass, pebbles or nodules of grey feldspathic sandstone	110
c. Silicious strata, less distinctly banded, and with similar conglomerate in the upper half	130
[These two divisions contain strata very closely resembling those of Oak Bay, Eagle Cliff and other points eastward, which contain an Upper Silurian fauna; but as we do not at present possess data for connecting them with that group of beds, they are in the following pages described as a part of the Mascarene series.]	
Division 3.	
a. Grey sandy flags and argillites, with much slaty conglomerate, especially in the upper part; the lower half darker, the upper half with elongated light-colored concretions	150
b. Grey sandy flags and slaty conglomerates; the upper half consisting chiefly of irregular sandstone beds with slaty conglomerate. [On a re-examination of this section it was found that some of the beds described as slaty conglomerate were really shales filled with hard concretionary, somewhat calcareous nodules, resembling pebbles or boulders of feldspathic sandstone]	80

c. Grey sandstones and flags more perfectly stratified...	120
In these beds there are layers more or less abundantly charged with remains of shells of the genera *Lingula* and *Modiolopsis*, and also occasional layers abounding with a small gasteropod (*Loxonema* ?) [The underlying beds, down to the summit of the black silicious rocks (2 *a*), where not too coarse, also contain these shells, but in a less perfect state of preservation; and the black strata themselves have obscure indications of shells in the paler layers, the darker ones being largely charged with comminuted vegetable matter.]	
Division 4.	
a. Measures concealed	130
Beds of which the lower third are greenish and reddish slaty sandstones, and the upper part red sandy argillite	120
Dark colored felsites and hard greenish argillite	60
	1,680

Division 5.

b. Dark red porphyritic felsite, like that south of the fault, forming a ridge between the road and shore. Thickness unknown, but probably 300 feet or more.

From McVickar's Beach to Clark's Point the shore-line runs along the basset edges of the grey flags, etc., of division 3, dipping inland at a low angle towards the hill of felsite (Division 5). At the point there is another fault throwing down the red argillites to a level with the grey sandstones. Here there is some trap (diorite ?), either intrusive or bedded with the red argillite, and in it are grains and strings of native copper and grey copper ore.

From Clark's Point northward the shore is bordered for some distance by the red sandy clay-slates of Division 4, underlaid by greenish-grey argillites. The dip, which is at first W. $<$ 50°, by a change in the course of the beds becomes N. 40° W. $<$ 50°, and across a beach is reduced to S. 30° W. $<$ 15°. Hence along a low bluff shore the beds incline to the eastward (E. $<$ 15°) and expose conglomerate similar to that of the section, which with the first named rocks folds over to the west, dipping N. 40° W. $<$ 80°. The same beds, much folded, form the face of the bluff for some distance further ; ledges of red conglomerate and grit appearing along the beach below high-tide-mark. These unconformably overlying red rocks, which are of the Perry group, rise into the bluff and extend along the shore to a beach, beyond which the Mascarene series again appears on the shore in ledges of greenish-grey sandstone and conglomerate, with a dip S. 30° E. $<$ 40°. On approaching the Mascarene Head dioritic beds, in connection with the red and green sandy argillites of Division 4, become more abundant, and with these form a ridge running across the head. These strata are at first vertical, but further on, folding over to the southeast, dip S. 30° E. $<$ 50°. The extremity of the head consists of sandstones of the Perry group.

The structure of the strata on the Mascarene shore would appear

to be due in the main to a series of sharp folds overturned to the north-northwest, or faults running east-northeast, having perpendicular strata on the north side, as in the section. These breaks are separated by long intervals in which the strata are inclined at a low angle. The axes of these folds, or the corresponding faults, are in places filled with intrusive traps, and are more or less charged with copper ores and sulphuret of iron.

The general strike of the rocks on the Mascarene shore is about north-east. In following this course to the Magaguadavic River a portion of the same series is met with, forming the shores of the estuary of that stream, on the northern side, to a point about three miles below the village of St. George. Here, however, the succession is less regular than on the Mascarene shore, and the relations of the beds are rendered perplexing by dislocations and faultings. Magaguadavic River.

At McLeod's mill-stream, three miles below the village, are the grey sandy fossiliferous flags of Division 3, having a southward dip of 30°, and holding *Lingula*, (a species similar, according to Mr. Billings, to one occurring in a collection of Dr. Dawson from Perry, Maine), a *Modiolopsis* and a *Loxonema*, the same genera as those noticed at Clarke's Point on the Mascarene shore. At various points along the shore of the Magaguadavic River there are associated with these flags the usual red and green argillites and dioritic beds of Division 4, with beds of red felsite as at the Mascarene. This shore-line is the course of a fault extending from the bluff of Perry sandstone near the river's mouth to the cove above McLeod's mill-stream; excepting a projecting hill around which the river is deflected half-way between these points, and behind which the fault runs. On the northwest side of this break lie the argillites and flags of Divisions 4 and 3, represented by the fossiliferous beds and associated red and green slaty rocks, and at a short distance from the shore red felsite, belonging to Division 5, forms a high hill (610 feet) named Mount Blair. Towards the mouth of the river they are unconformably covered by an outlier of the Perry rocks. Fossil

Along the shore between the harbors of Magaguadavic and Digdequash, the Mascarene rocks present some differences in the inferior beds. The felsite ridge (Division 5), culminating in Mount Blair, runs out westward into a little island close to the shore, about half-way between these two harbors, and returns again to the shore at the point northwest of this island. On this point, and just behind it to the northward is the following succession in descending order:—

Dark grey porphyritic felsite.
Dark brown slaty felsite.
Hard green argillite.
Purplish-red argillite.
Fine grained grey sandstone (Div. 3,) with light green epidotic (?) concretions, Dip S. 30° W. < 20°.
Grey slaty conglomerate, or slates with hard feldspathic concretions.

Hard greenish-grey sandstone.
Purplish-red clay-slates.

There would appear to be here red argillites below as well as above the grey sandstone seen at the Mascarene shore. The lower ledges are covered by a shingle-beach, beyond which are dark colored conglomerates of the Perry group. At the next point (Oven Head), dark red slaty felsites again come out upon the shore, dipping S. 70° W. < 50°. These are underlaid by the green argillite of Division 4, which becomes horizontal and is crossed by a fault having a course N. 30° E., and a southerly underlie of 80°, beyond which the red felsites of Division 5 are again repeated with a low southerly dip. Opposite a small island of conglomerate of the Perry group, the green slates again come out upon the shore on the east side of the entrance of Digdequash Harbor, but are almost immediately covered by felsites, which form the shore on this side of the harbor for half a mile, dipping S. 60° W. < 30°; the argillites and sandstones (Divsions 4 and 3) forming a higher ridge in the rear of these, one of a succesion of ridges which extend back to the granite hills.

Supposed structure.

These parallel ridges may be well seen in advancing northward from Magaguadavic village. They comprise a series of claystones or felsites; some of these weather greyish-white with rough angular surfaces, while others are slaty and hold fragments of slate, but the majority are of a dark red color weathering to brick-red). These alternate with grey feldspathic slates, amygdaloidal trap and bright red clay-slates. This succession of feldspathic beds and felsites we believe to be repetitions, in part at least, of the strata in Divisions 2, 3, 4 and 5 of the Mascarene series, lifted up against the intrusive granite on the Magaguadavic River by a succession of parallel faults, and the equivalents of the similar rocks on the Mascarene shore; in other words, that these, with the corresponding beds in the peninsula last named, are different sides of the same basin, here wedged in between the band of Lower Kingston rocks southward and the granite on the north. On the Mascarene side of the basin, however, the series is overturned and flanked by the Kingston rocks brought up by a fault, while north of the Magaguadavic they have their normal position, with a moderate dip southwardly. The several divisions, however, are repeated in a series of outcrops caused by faults along which the strata are thrown down on the side next the intrusive granitic mass. This view of the relations of the Mascarene series in this vicinity is confirmed by what is seen in other portions of the same basin, as for example at Lake Utopia.

Lake Utopia.

Among the rocky hills around this sheet of water are exposures of strata which cannot be distinguished lithologically from the Coldbrook group. These very closely resemble those of Divisions 4 and 5 of the Mascarene succession in this area. Both of these series are probably represented in the ledges crossed in making the traverse here given along the east shore of Lake Utopia.

The section begins near Ludgate's mill, a little above Trout Creek, southward of which for one and a half miles the rock is red granite, like that of the Nerepsis hills.

Section at Lake Utopia.

	Traverse measure. FEET
Measures concealed, with the exception of exposures at the end of greyish-black petrosilicious rock, dip. S. 10° W. < 70°.	300
Ridge, lower half of which is diorite	200
Measures concealed, including Trout Creek	3,860
Silicious slate and slaty conglomerate ... ... } Purple feldspar-porphyry : .. .. }	700
[The silicious slates are also seen at the north end of Milligan's Island, where they dip S. < 70° and alternate with beds of dark grey diorite, followed on Spark's Head and Island by dark slaty conglomerates which are slightly amygdaloidal. The latter dip S. < 60°.]	
Clay-slates and conglomerates	250
Measures concealed	600
Purplish-grey and greenish-grey argillites and sandstones. Dip S. 40° E < 80°. Division 4	250
Exposures of greenish-grey sandy argillites of Mascarene series Dip in the last 300 feet N. 30° E. < 80°...	1,300
Measures concealed	500
Diorite chiefly	250
Grey sandy argillites, including three feet of diorite	200
The measures are then concealed for one hundred and fifty feet, beyond which to the post-road at Reardon's Inn, similar grey argillites, some of which are fine, dark and porphyritic, are met with, alternating with beds] of diorite. These grey argillites and diorites probably pertain to the lower portion of the Kingston group.	

On the western side of Lake Utopia, from the Thoroughfare or canal southwards, the succession is similar to that above given, but here the feldspathic sandstones of Division 3 hold casts of shells resembling *Modiolopsis*, while dark purple felsites, not distinguishable from those of some portions of the Huronian series as seen in St. John and Queen's County, which are scarcely visible on the eastern shore, rise into the eminence known as Troak's Mountain. Troak's Mountain.

From the Magaguadavic River, near Lake Utopia, the Huronian and Mascarene rocks sweep around to the Digdeguash River, being as before mentioned disclosed in a series of parallel and prominent ridges between the granite hills (whose course they follow) and the shore of Passamaquoddy Bay. All of the beds mentioned above as occurring upon Lake Utopia are also well displayed on the Digdequash River, where, too, the repetition by faulting, to which reference has been made, is very apparent. The lowest beds seen here as at other points (excepting a little diorite), are grey feldspathic and petrosilicious strata dipping nearly west at an angle of 40°. These, the dip changing to N. 50° W. < 30°) are followed on the east side of the Digdequash River.

river by dark grey, light-weathering, and reddish-grey porphyritic felsites portions of which are concretionary, presenting at the surface the aspect of a felsite-conglomerate composed of rounded masses of felsite in a grey feldspathic base. On the western side there is also a ridge, the summit of which is composed of a laminated dark reddish felsite (Division 5), but in following this southward, a fault is met with, along which these felsites abut against amygdaloidal diorites, associated with purple and grey argillites, etc., which belong to Division 4; the felsite beds by which these were once capped having been removed by denudation. On the shores of Digdequash Basin the felsites first mentioned may be seen to graduate into feldspathic beds of a dark grey color and more or less flinty character, which extend thence to the bridge and post-road near the mouth of the river. The usual succession of dioritic beds overlaid by red felsites is again seen in the next ridge towards Bocabec.

The Mascarene rocks of the Digdequash River, following the trend of the granite hills whose slopes they cover, extend up this stream, with a course nearly north, for several miles. On the western side they are met by the coarsely crystalline dioritic rocks described in the section on the Laurentian system, which here approach the shore of Passamaquoddy Bay. The Mascarene rocks are not tilted up against these diorites, but mantle around southwardly projecting ridges, and fill the indentations of the more ancient series. Between the stream last named and the Bocabec River, Division 4 of this series is well exposed, and presents the same features as above noted—*i.e.*, a series of bold parallel ridges composed of compact and amygdaloidal diorites, around which in the valleys appear the grey and purplish-red sandstones, both several times repeated by uplifts and separated by denudation. The dip of the sandstone beds at the mouth of Bocabec River is W. $< 30°$.

Bocabec River

Just beyond the bridge which crosses the stream last mentioned, the post-road winds around the southern flank of a high ridge of dioritic rock, at the base of which purple sandy shales are exposed with the same dip as above. This ridge, which includes both compact and amygdaloidal diorite, and which in some parts is coarsely crystalline, appears to be connected with the great mass of crystalline rocks described in preceding pages as occurring to the northward of this point, rather than with the Mascarene series. Another spur, composed of similar rocks, comes down to the post-road about two miles further to the west. Between these ridges and around their flanks arenaceous beds outcrop at several points, and are well exposed on the shore of Bocabec Bay, where they consist of hard grey feldspathic sandstones of a somewhat dioritic aspect, containing epidotic layers and nodules, and dipping northward at an angle of only 5°. On the hills above, between these sandstones and the older rocks, are beds of felsite of reddish and greenish tints, and fine grained grey schistose rocks, which, if not of Huronian age, may re-

present Divisions 5 and 4 of the Mascarene series. The relations of these beds are obscured by numerous faults.

A peninsula separates Bocabec Bay from Chamcook Bay. Through this peninsula runs a line of fault with a course about east (magnetic). North of this line are ridges composed of grey sandstones and diorites, dipping S. W. $< 10°$ which are partly crossed by the post-road. South of the same line of fault, which itself has an underlie of 80° to the southward, are layers of dark grey felsite, nearly vertical. These are much contorted, and are mixed with dioritic felsites containing specks of kaolinized feldspar. Towards the south side of a knoll composed of these rocks the dip decreases, and at the foot the felsites of Division 5, of the ordinary dark red color, occur in thick beds. A higher hill, opposite the last, is almost entirely composed of a red compact felsite, around the base of which appear the sandstones and diorites of Divisions 3 and 4, on the western shore of Bocabec Bay. Chamcook Bay.

The relations of the different members of the Mascarene series, which along the shores of Passamaquoddy Bay are thus complicated by faults and denudation, are somewhat more apparent further inland, about the Chamcook Lakes and along the eastern shore of the St. Croix River. Near the former they may be well seen in the cuttings on the line of the St. Andrew's and Quebec Railway.

About the upper or more northerly of the Chamcook Lakes, and near Bartlett's station, the rocks are chiefly granitoid, consisting in part of dark colored granitic and syenitic gneiss of the Laurentian type, and in part of imperfect syenites with much red feldspar, like certain rock-masses which border the intrusive granite of the Nerepis Hills. With both of these, but particularly near their junction, and over the surface of the latter, are small beds of diorite and fine grained dioritic felsite, through which pass veins of red feldspar and red syenite, connected with the mass of similar underlying rocks. Beds of like character have been observed about Bocabec, at the foot of Bonaparte Lake, and elsewhere over the great granitic tract which lies to the northward of Passamaquoddy Bay, and may be outlying patches of Mascarene rocks. The first considerable beds of this character met with on the railway are near the eight-mile post, and consist of fine grained grey and dark grey feldspathic rocks, which are more or less porphyritic and jaspery. These are the same in character as the finer beds of Digdequash Basin, and like them pass into and alternate with red crystalline felsites. They represent Divisions 1 and 2 of the Mascarene series. The rocks in question are distinctly bedded, having a southerly dip of about 40°, in which direction they are followed, near the head of the second Chamcook Lake, by fine grained grey feldspathic sandstones. With the latter are numerous dykes and beds of intrusive diorite, by which the sandstones appear to have been locally altered, their flaws and crevices in the vicinity of such dykes being frequently charged with crystalline epidote. In following these beds to the southward, their dip Chamcook Lakes.

is found to gradually decline to about 20°, with several low undulations. At the head of Chamcook Lake they dip towards and apparently beneath considerable masses of fine grained felsite or orthophyre. This rock varies in color from flesh-red to brick-red or purplish-red, weathering to a lighter, often bright red color, and is frequently porphyritic with small grains and crystals of lighter red feldspar. It is sub-translucent, breaks with a broad conchoidal fracture, and is irregularly jointed, both the joints and the mass of the rock sometimes containing thin seams and coatings of pale green epidote. These felsites may be seen capping the high hills on the lower part of the Frye and Glenelg roads. At the foot of these hills and along the shore of the lake they are associated with diorites, some of which are coarsely amygdaloidal, these trappean beds appearing to have been irregularly injected into the joints of the feldspathic rocks as well as spread in layers, which, with the felsites, here dip northerly at a low angle. Towards the foot of the lake hard grey sandstones again come into view, but are here associated with purplish-red and green crumbling argillites, both in low undulations. The sandstones resemble those of Bocabec Bay, like them holding epidotic bands and nodules, and represent Division 3 of the Mascarene series.

The opposite or western shore of Chamcook Lake shows at this point rocks of very dissimilar character to those above described as occurring along its eastern margin. These consist of very hard and flinty dark grey petrosilex, uniformly porphyritic with small light colored feldspar crystals, weathering soft and of a pale grey color. They skirt the lake for a quarter of a mile or more, and are the eastern flank of a great mass of such rocks, of very homogeneous character, forming the high and precipitous hills culminating in Chamcook Mountain, which attains, according to the Admiralty Survey, an elevation of 637 feet. The Mascarene strata lie around the northern and eastern sides of this mass in nearly horizontal beds. Its western and southern slopes are covered by conglomerates of the Perry group, which fill valleys of erosion in the older rock, and are in part made up of the ruins of the latter.

Chamcook Mt

The relations of the Mascarene strata as exposed on the eastern shore of the estuary of the St. Croix River, are, in the main, similar to those seen about the Chamcook Lakes. At a point a little above Bradford's Cove, seven miles from the town of St. Andrew's, red syenites, distinguished by a predominance of flesh-red feldspar and by the presence of hornblende, (which, in variable proportions is scattered through the mass,) form the shore, and have been more particularly described in an earlier portion of the Report. These are the same in character as the imperfectly syenitic rocks of the Upper Chamcook Lake, and are, in like manner, covered by small beds of fine grained grey and dark grey feldspathic rocks, into which veins of the red granitoid mass are sometimes seen to penetrate. Similar fine grained feldspathic rocks immediately succeed the red syenites at their southern edge; these, at their contact with the crystalline mass, being reddish, but at the distance of a few

St. Croix River.

feet becoming of a dark grey color. These are probably the same as the darker felsites occupying a similar position about the Chamcook Lakes and Bocabec, and may pertain to Divisions 1 and 2 of the Mascarene series. Their thickness, however, at this point is inconsiderable, they being followed near Bradford's Cove by amygdaloidal and compact diorites, associated with hard purplish and grey micaceous sandstones. Layers in these latter, somewhat softer than the mass of the rock, contain well preserved shells of *Lingula* and *Modiolopsis*. The sandstones, which are nearly horizontal, alternate with finer beds containing blotches and bands of a pale grey color, and represent Division 3 of the Mascarene series. Both are cut by dykes of diorite, producing a partial alteration of the strata; the sandstones in proximity with these intrusive masses having often a dioritic aspect, and their crevices lined with thin layers of crystalline epidote. South of Bradford's Cove, similar alternations of sandstones and finer grey and yellow-striped petrosilicious rocks, in beds of from four to five feet in thickness, extend along the shore for several rods, being, as before, associated with dykes of diorite or dolerite, which both intersect the beds and at times bend over to form layers between them. The dip is low with gentle undulations. About a furlong below Bradford's Cove red sandy argillites and sandstones of Division 4 come into view, the former characterized by a strong slaty cleavage intersecting at a high angle the nearly horizontal stratification of the beds. With these, fine grained dark-colored felsites of the same division are met with, which are often porphyritic and filled with blotches of paler color, passing into a purplish-red slaty amygdaloid. Towards Sand Point the inferior grey sandstones of Division 3 again rise to the surface, but are here overlaid by a thick bed of dark grey conglomerate, probably of the Perry group, the matrix being feldspathic, the pebbles (which are mostly angular) consisting of dark grey felsite, red sandy clay-slate and grey yellow-striped petrosilex, evidently derived from the underlying sediments. Their dip is S. $< 20°$. This conglomerate is cut off vertically by a fault, occupied by a dyke of dolerite, beyond which the grey sandstones again form the shore, and with dark felsites and trap-beds extend to Sand Point.

Fossils.

For a quarter of a mile below the promontory last named, high bluffs of sand and gravel conceal the rocks from view. The grey sandstones then re-appear, and with grey-banded petrosilicious beds, grey amygdaloid and red sandy clay-slate (the latter with pebble-layers parallel to the bedding) form the shore as far as Johnston's Cove, both in low undulations, and with frequent faults, the sandstones graduating into the slates both in color and texture. A few rods to the north of the cove last named, these red clay-slates (Division 4), having a dip N.E. $< 20°$, are unconformably covered by reddish conglomerate dipping S. 30° E. $< 10°$, and holding pebbles of red and grey sandstone. Similar conglomerates with coarse red sandstones are met with on the south side of the same cove, dipping very regularly southward at an

angle of 20°. Near the cove they overlie the red sandy slates of Division 4, but to the south sink gradually to the level of the river, of which they form the shore thence to Brandy Cove. These conglomerates are similar to those of the St. Andrew's peninsula, and with them appertain to the Perry group.

It will be seen that on this shore no higher beds of the Mascarene series than those of Division 4 come into view, the dark red and brownish-red felsites of Division 5, (which are so abundant about the Lower Chamcook Lake) being absent, or perhaps concealed by the conglomerates of the Perry group.

Robbinston.

In a somewhat cursory examination of the opposite or western side of the St. Croix River, the shore of this estuary, through the greater part of the town of Robbinston, in the state of Maine, was found to be composed of imperfect red syenites, similar to those already described on its eastern shore, above Bradford's Cove. These, however, are covered, at a point nearly opposite Johnston's Cove, by small beds of dark grey slaty feldspathic rocks and red feldspar-porphyry, the dip of the former being N.E. $< 50°$. To the south of a small cove in which these beds are disclosed, soft red conglomerates of the Perry group are met with, dipping S. $< 20°$, and forming an outlying portion of a series which is spread over much of the township of Perry. The relations of these to the older Mascarene rocks may be well seen in the southern portion of this township and on Moose Island, on which the town of Eastport is situated.

Eastport.

The rocky surface of Moose Island gives excellent facilities for the study of its geological structure. Fort Sullivan at Eastport is situated upon a hill of reddish porphyritic felsite (Division 5 of the Mascarene series) having a felsite-breccia conglomerate below, filled with flat pieces of rock arranged in parallel bands. These may be seen in the street below the fort, where also the underlying trappean beds appear. The latter (Division 4), in the form of grey amygdaloidal diorite, constitute the front and western portions of the town as far as Salt-works Cove. They also rise from beneath the felsites on the eastern side of the island, where they have been found to contain small quantities of copper-ore. At the head of Salt-works Cove beds of grey petrosilex come into view, together with a conglomerate of no great thickness, composed of fragments of petrosilex cemented by a paste of fine grained diorite. These conglomerates appear to extend across the peninsula separating the last named cove from Broad Cove, the remainder of this peninsula, which terminates in a high bluff overlooking Cobscook Bay, being mostly composed of compact and amygdaloidal diorite. We are informed by Professor A. E. Verill, that he has met with fossils in the strata near Salt-works Cove. These have not been observed by us, but upon the eastern and northern shores of Broad Cove fossiliferous beds, probably similar to those observed by Professor Verrill, have been met

with, and nearly resemble those of the Mascarene shore on the eastern side of Passamaquoddy Bay.

The relations of the strata on the shores of this cove are somewhat obscured by faults and folds, but the following would appear to be the general succession in ascending order :—

Near the entrance of the cove on its northwest side, high bluffs, overlooking the waters of Cobscook Bay, consist of greenish-grey, and reddish grey felsites weathering dull reddish-grey. These rocks are coarsely porphyritic, break with an angular or sub-conchoidal fracture, and exhibit but faint traces of stratification (? N. 40° E. < 20°). They include also dark grey rocks of the same character, which are porphyritic and very crystalline, and bear much resemblance to portions of the Huronian series, as seen in the eastern part of St. John and King's Counties. In passing around these bluffs towards the interior of Broad Cove, the dark felsites last named appear to pass into a grey porphyritic feldspathic sandstone, forming a bed of small thickness, which is immediately overlaid by a dark fine grained non-porphyritic feldspathic rock, which varies from a fine grained felsite to a fine grey feldspathic sandstone, and in the inferior portion contains fragments, from six to eighteen inches in diameter, of fine grained dark porphyritic rock. The dip of these beds is N. 60° E. < 20. The more arenaceous portions contain numerous vesicles filled with calc-spar, some of which simulate the forms of brachiopodous shells. The sandstones in question are covered conformably by a bed, four inches thick, of grey semi-crystalline porphyritic sandstone, and by fine grey sandstones, containing layers filled with fossil shells. There is then a small space in which the measures are concealed, beyond which hard grey porphyritic sandstones, somewhat coarser than the above, come into view in nearly horizontal beds. Over their upper surface, and partly filling up hollows in the sandstone, are dark fine grained shales, also containing fossil shells, among which are numerous casts of a small gasteropod, resembling *Murchisonia*. A dyke of diorite then occupies the shore for two hundred yards, over whose surface the fossiliferous shales are spread, the dip of the latter increasing to N. < 70°. A fault is then met with, bringing up fine grained dark grey feldspathic rocks, portions ofwhich are petrosilicious, with shadings of grey and white, and others a hard grey shale. These rocks, which in some portions contain pebbles or concretionary masses, are the beginning of a ridge running a little west of north, and rising into the bluff known as Shackford's Head. At the foot of this nearly perpendicular wall of rock, soft grey fossiliferous shales again come into view. These are mostly thin bedded, soft and fissile, and are filled with shells of *Lingula* and *Modiolopsis*, with which some obscure plant-remains have also been imbedded. These fossil-bearing strata rest upon somewhat coarser greenish-grey shales, and both are much crumpled and folded, presenting the appearance of having been overturned against the harder strata above mentioned, which form the

Broad Cove.

Fossils.

upper portion of the cliff, and again come down to the shore towards the eastern side of the latter.

A beach, a few rods in length, forming the northeastern corner of Broad Cove, separates the strata of Shackford's Head from those which skirt the eastern shore of the same cove. The first rocks met with in this direcion are rather coarse conglomerates, holding pebbles of dark purple felsite, reddish feldspar-porphyry, amygdaloidal diorite and epidote, imbedded in a sandy feldspathic paste. These conglomerates, having a low easterly dip, are directly overlaid by a bed from fifteen to twenty feet in thickness, of purplish-red felsite, beyond which for a few rods alternations of similar strata are met with. The low bluffs which then skirt the shore are mostlycomposed of fine grained felsites, varying in color from pale red to brownish-red and purplish-red. Portions of these rocks are very homogeneous, porphyritic, and filled with crystalline epidote (the latter lining flaws and crevices in the rock, as well as being scattered through its interior in the form of small nodules). They are not readily distinguishable from the felsites already alluded to as forming the bluff to the west of Shackford's Head, near the entrance of Broad Cove, and may with these be bosses of Coldbrook rocks, such as are elsewhere met with around the shores of Passamaquoddy and Cobscook Bays; but the alternations of others with conglomerates made of similar materials, and the faint bands of color often met with parallel to the stratification, show that the greater part are recomposed sediments, similar to those elsewhere described as overlying the fossiliferous strata of the Mascarene shore. These reconstructed rocks, varying in color from green to red, and dipping at a low angle towards bluffs of purplish-red epidotic felsite, appear along the eastern shore of Broad Cove for half its length. Inferior beds then come into view, consisting of purple shales underlying grey sandy flags and sandstones, which, together with several beds of slaty conglomerate, form the remainder of this shore to a small cove at its southeastern end. These arenaceous beds contain numerous layers filled with poorly preserved lamellibranchiate shells, and at one point may be seen to rest, in a nearly horizontal attitude, upon a projecting mass of highly crystalline and epidotic felsite. Their dip at the cove alluded to is N. 20° E. $<$ 60°.

Broad Cove

Near this point the post-road, which traverses the length of the island, approaches within a few rods of the shore, passing along the western side of a low ridge of feldspar-porphyry continuous with that already noticed beneath Fort Sullivan. These felsites are much like those noticed on the shores of Broad Cove, and are probably recomposed sediments, exhibiting similar evidences of stratification in the occurrence of numerous color-bands, dipping N. 20° E. $<$ 10°, while portions of the rock are filled with cavities, some of which present an appearance of having once contained fossils. These red-weathering felsites extend to the neck of the island, which is a low flat of modified drift. Beyond it the rocks rise into steep hills, known as

Kendall's Head, which on the eastern side present perpendicular faces of grey sandstone, and a rock which is either a grey conglomerate with hard grey feldspathic pebbles, or a sandy shale filled with hard concretions, overlaid by greenish-grey schistose dioritic rock, all dipping north at low angles. These arenaceous beds are the counterparts of the beds on the Mascarene shore included in Divisions 3 and 4. Near the toll-bridge there are beds of schistose diorite, like those on the head. At the Perry end of the bridge there are on the shore ledges of red conglomerate, dipping N. 60° W. < 15°, and holding pebbles of the red felsites of Division 5, grey sandstones of Division 3, and red crystalline felsite and syenite, such as are abundant farther north in Robbinston. These conglomerates belong to an overlying series which we have designated as the Perry group.

Just northward of the above, rocks of the Mascarene series again rise to the surface. They are bedded diorite, and greenish-grey schistose dioritic beds, having a dip S. 20° E. < 15°. There is then a low anticlinal exposing the same beds, and also the slaty rock with grey pebbles or nodules seen at Kendall's Head. Upon this ridge the post-road to Pembroke diverges westward from that to Perry, which runs to the north.

On the first named road, as far as a cove which puts in from Cobscook **Pembroke.**
Bay, there are several undulations in the beds, the ridges consisting mostly of the felsites of Division 5, and the lower grounds of dioritic strata belonging to Division 4. Between this and a long narrow cove opening out upon the same bay, the latter rocks rise into a ridge covered on the side next the first cove by red felsites. Beyond the long cove, and still descending upon the series, the red and green slates of Division 4 come into view, with a dip N. 50° E. < 30°, and are filled with cleavage-planes, dipping N. 20° W. < 80°–90°, or nearly at right angles with the bedding of the slates. A fault then intervenes, and the slates are concealed from view beneath a mass of diorite, with crystals of green feldspar. This rock forms a long ridge running north and south and overlooking the village of Pembroke, which is built upon the red slates appearing again beyond the diorite, and occupying the bottom of a valley which opens out into a cove connecting with Cobscook Bay.

In this district, the faults connected with displacements of the strata have a course different from that at Moose Island, being nearly north and south, and indicate an approach to the border of the basin of Mascarene sediments in this quarter, which should have here a trend corresponding to the course of the faults.

Not far south of the village last named fossiliferous Upper Silurian strata come into view on the shores of Pembroke River, with a dip N. 40° E. < 40°. It may be remarked in this connection, that at various points about the shores of Cobscook Bay and its numerous indentations, felsites may be seen, bearing much resemblance to those already described as occurring near the town of

Eastport, at Broad Cove and elsewhere; and (if not of Coldbrook age), belonging to the series now under consideration. Of these, the most marked form the eastern shore and the extremity of Seward's Neck, a peninsula separating Cobscook Bay from South Bay. These felsites are fine grained, mostly light colored, of pinkish and reddish-grey tints, but include also darker beds of similar composition, some of the latter being traversed by bright red color-bands. Both are associated with dykes (and beds ?) of hard grey epidotic trap, and are more or less filled with specular iron, coating the surfaces of flaws and crevices, as well as scattered in scales through the mass of the rock. A similar rock, also containing specular iron, occurs in the township of Trescott, and has been mined for this ore.

Pigeon Hill.

But to return to the Perry road; just north of the point at which the road to Pembroke diverges from the latter, is a low eminence known as Pigeon Hill, at the base of which are soft red and grey sandstones, first noticed by Professor C. H. Hitchcock as containing *Lingulæ.* These are like the strata of Divisions 3 and 4 of the Mascarene series, with whose fossils those of Pigeon Hill have also been in part identified. The crest of this hill consists of black and dark grey petrosilicious and rusty-weathering rocks, with vertical cleavage. These resemble the lower beds of the Mascarene series, brought up by a fault, and probably correspond to the banded petrosilex (Division 2) of the Mascarene shore. In the hollow north of Pigeon Hill, these rocks are covered by conglomerates and sandstones of the Perry group, having a dip N. 40° W. $< 15°$. From this point onward towards Little River, runs a low ridge, perhaps an anticlinal, of dioritic rocks and purplish-red argillites (Division 4), with a dip or cleavage N. 40° E. $< 30°$. At a small brook which crosses the road one and a quarter miles south of the post-office in Perry, there is a purplish-grey diorite, flanked on the east by the characteristic dark red felsite of Division 5. Here we meet an area of overlying red sandstones of the Perry group, which extends across the township of Perry to Robbinston. It is in a low cliff cut in the rocks of this series, on the side of Little River, that the Devonian plant-remains of Perry are found.

UPPER SILURIAN SERIES.

THE occurrence of Upper Silurian strata in the southeastern part of the state of Maine had been pointed out some years previously to the recognition of rocks this of age in New Brunswick. History.

In the first Report of Professor C. H. Hitchcock on the geology of Maine, the rocks in the eastern part of Washington County in that state were described as to a great extent referable to this horizon, fossils of Upper Silurian type having been discovered in the less altered beds occurring near the towns of Pembroke and Lubec. The apparent extension of the rocks of this county through the islands of Passamaquoddy Bay into Charlotte County, New Brunswick, together with a general resemblance of the former in lithological characters and mineral products to such as had been examined in the county last named, suggested the probability that the two were in part identical, and that strata of this age might be largely developed among the metamorphic sediments of the southern coast. This conjecture received confirmation from various facts observed farther eastward, but principally from the discovery of certain organic remains, consisting of corals, shells, and trilobites, in the rocks of Frye's (or Cailiff) Island on the southern coast of Charlotte County, just east of Passamaquoddy Bay. A list of the fossils referred to, as prepared from very imperfect collections, was published in a note to our Report to the Legislature of the Province in the year 1865, and their age alluded to as probably Middle or Upper Silurian, a conclusion subsequently confirmed by Mr. Billings.

At the time of the publication of the Report in question no examination of this portion of the coast had been made, nor was it known how far the rocks of the Passamaquoddy area might be connected with those observed along the St. John River in St. John and King's Counties. It was therefore conjectured that the fossiliferous strata of Frye's Island might form a portion of the same series as that traversing the central portion of King's County, to which we had assigned the provisional name of the Kingston group. A more careful study of the district, however, having failed to show that the two are connected, it is proposed to consider here those strata about whose Upper Silurian age there can be no question.

The areas in which rocks of this formation have been recognized are three in number. The first embraces a portion of Frye's or Cailiff Island, and part of the adjacent Mascarene peninsula, the rocks here being chiefly grey flags and shales, included among folded beds of the Coastal and Kingston groups. The second, which is also of limited extent, includes portions of Upper Silurian areas.

the shores of Oak Bay and Waweig Inlet, on the St. Croix River, where the strata are also grey shales resting upon grey felsites with some diorite, and including at the base heavy beds of grey silicious conglomerate. The third region embraces portions of King's and Queen's Counties, where rocks of this age cover considerable areas on either side of the range of intrusive granites known as the Nerepis Hills. In the valley of the Nerepis River, on the southern side of these eminences, the strata in question consist of fine grained petrosilicious rocks and diorite, alternating with dark fissile carbonaceous slates, of which the former abounds with marine organisms, and the latter are filled with evidences of land-vegetation. Near the base, the fossiliferous silicious rocks alluded to alternate with beds of dioritic felsite, and rest upon red crystalline felsites, which appear to be connected with the underlying granitic mass, while at their summit there occur, with the petrosilicious rocks, beds of fine grey slate-conglomerate. Further east, along the southern flank of the same crystalline belt, and among the hills of Huronian age which occur about its eastern termination, the Upper Silurian rocks are chiefly hard slates of pale grey colors in the lower beds, and including considerable masses of diorite, but the upper beds are softer and of a dark grey color. Both abound in marine organisms.

A thick mass of grey feldspathic quartzites and interstratified diorites, met with along the northern flank of the Nerepis Hills and in the Nerepis Valley, is supposed to be of this age.

The following notes embody more detailed descriptions of these several regions.

Details of the Upper Silurian Series.

Upper Silurian in Frye's Island and Back Bay.

The fossiliferous strata of Fry's Island, to which reference has been made, occupy but a small portion of its surface, being confined to a narrow strip skirting its southern shore. They here lie at the foot of a long and narrow metamorphic ridge, which separates them from crystalline metalliferous limestones to the northward of them. Southward of the Silurian strata are scattered islands of red conglomerate. The general arrangement of these beds is indicated in the following section, which begins immediately southward of the ridge of hard rocks alluded to above :—

Frye's Island

1. Red felsite, often quartzose.
2. Grey slaty conglomerate, with pebbles of slate, etc.
3. Grey flags and slates ; the lower beds mostly thick flags, but having much shale about the middle and towards the top, where it is highly fossiliferous. These beds contain *Favosites*, *Zaphrentis*, *Syringopora*, *Discina*, *Orthis*, *Strophomena*, *Rhynchonella*, *Atrypa*, *Spirifer*, *Loxonema*, *Murchisonia* (two species), *Orthoceras*, and other genera.

4. Soft dark grey shales, including a few harder masses, which are perhaps concretionary. This rock is sparingly fossiliferous, containing small brachiopods, etc. In the folds near the metamorphic ridge it is hardened.

These Upper Silurian rocks are succeeded by the red conglomerates and sandstones alluded to above, which form several small islands at a short distance from the shore. They dip towards the Silurian beds at a low angle. There is a small outlier of this rock on Frye's Island, but it is west of the line of section.

The northern shore of Frye's Island is separated from the main land of the Mascarene peninsula by a sheet of water from one half to three quarters of a mile in width, known as Back Bay. On the southern shore of this peninsula, and just east of the promontory of La Tête Head, there are some low points of rock, from which the following fossils, determined by Mr. Billings, were obtained :—*Heliolites intercinctus* (which occurs also at Pembroke in Maine); *Favosites* (?) probably *F. Gothlandica* ; *Strophomena rhomboidalis* ; *S. punctalifera* ; *S. varistriata* ; *Orthis*, a new species, occurring also in the Gaspé limestones ; *Orthis* (?), a small finely striated species ; *Spirifera nympha*, which occurs also at Square Lake in Maine ; *Dalmanites*, one of the lateral posterior spines of the head, most probably *D. Epicrates*, which occurs also in the Upper Silurian at Stair Falls in Maine ; and *Encrinurus*, of which several tails and fragments of the head were found. These fossils, which Mr. Billings speaks of as decidedly Upper Silurian, occur in soft dark grey shales, dipping S. 30° E. < 70°. They are overlaid at the extreme point by dioritic quartzite, and rest upon green diorite. These are, in turn, underlaid by hard greenish-grey fossiliferous shales, with hard limestone bands, dipping S. 30° E. < 90°. Beyond them to the north are diorite and grey and reddish quartzite, with dip or cleavage N. 30° W. < 50°. After a short space, in which there are no rock-exposures, hard shales are again met with, accompanied by dark quartzite (dip N. 30° W. < 80°.) With these are red, purplish and greenish-grey slates, which are nearly perpendicular. They are just at the foot of the high slate ledges terminating in La Tête Head. This promontory is composed for the most part of crystalline schists and dioritic rocks of the Kingston group, but farther to the north, at Mill Cove, there is a fault running in a northeasterly direction, by which these rocks are let down, their place being occupied by hard dark grey shales with dark grey and black quartzite, containing fragments of corals and crinoidal joints, very imperfectly preserved. These are probably of Upper Silurian age. The remainder of the shore of La Tête Harbor consists of low ledges of hard shales, which are partly chloritic, and have numerous though obscure ribbed shells, one of which appears to be a *Rhynchonella*. They dip S. 10° E. < 70°. Beyond them, the measures seen in La Tête Head again come to the surface.

Black Bay.

Obscure fossi

It is not improbable that rocks of Upper Silurian age, being in continuation of those above described, may occur upon Deer Island and some of the

smaller islands south of Passamaquoddy Bay, these being in the direct line of those of Frye's Island and La Tête. None such, however, have yet been identified, the greater portion of this chain of islands as described in an earlier portion of the Report, being composed of rocks of the Coastal and Kingston groups The only beds observed which appear to be of more recent origin, and which may be of Upper Silurian age, were met with on Harris's or Folly Island, towards the western limit of the chain. They consist of light grey sandstones and slates, conspicuously banded with thin alternating layers of unequal hardness, and in some parts much stained with yellow ochre. They rest unconformably upon pale grey crystalline felsites, and dip S. 50° W. < 60°.

With a view to a comparison of the Upper Silurian rocks of Charlotte County, New Brunswick, with those of the same age in Washington County, Maine, opportunities have been embraced of visiting several points about Cobscook Bay, from which fossils of this age were known to have been obtained. Of these the most interesting is the Pembroke River. On the west side of this stream, a few miles below the town, there are exposed by the tide low bluffs of dark grey slates, having a dip N. 20. E < 40°, overlaid by beds of hard grey sandstone (with intercalated thin beds of slate) and dark grey diorite. Fossils occur sparingly throughout the slates, which are more or less calcareous, and in some parts make up almost the entire bulk of the rock. We have collected, principally from the higher beds, the following genera, determined by Mr. Billings to be of Upper Silurian age;—*Chonetes, Rhynchonella, Pterinea, Grammysia, Modiolopsis, Pleurotomaria, Murchisonia, Orthoceras, Dalmanites* and *Pterygotus*. The horizon of this locality is probably not far from that of Back Bay in La Tête Harbor, and one species, *Heliolites intercinctus*, is common to the two.

Pembroke

Fossils.

A second locality from which we have obtained fossils of Upper Silurian age in this region is Denbo Point, the northern extremity of the peninsula which forms the western side of South Bay. On this promontory, near the works of the Denbo Lead Mining Company, the rocks consist of dark purplish-red conglomerate, underlying fine grey conglomerate, the latter alternating with hard grey and purple sandstones and hard grey shale. With these are thinner beds of diorite, all being more or less epidotic. Their dip is N. 30° E. < 40°. The fossils, which occur abundantly in the sandstones and shales, are not well preserved, but include the following genera, also determined by Mr. Billings, and regarded by him as probably Upper Silurian;—*Favosites, Chonetes, Orthis, Orthoceras* and *Encrinurus*.

Nearly midway between Denbo Point and Cobscook Falls, but on the opposite side of the bay from the promontory first named, is a third locality in which fossiliferous strata of Upper Silurian age have been met with. These occur upon the shore of a long and narrow indentation, known as Long Cove, which penetrates the peninsula separating the valley of Pembroke River

from that of Dennysville. On the western side of this cove the strata are grey silico-feldspathic beds, having lines of paler color, on the surfaces of which are numerous ribbed shells and branching corals resembling *Syringopora*. Numerous pale coloured nodules are also contained in the mass of the rock, some of which simulate the forms of corals, but of which the structure is no longer discernible. The dip of these beds, which have a thickness of about fifty feet, is N. 40 E. < 70°. They rest upon diorites, and dip towards a mass of similar rocks of coarsely crystalline aspect, from which they are separated by a small arm of Long Cove. On the other side of this arm, and beyond the diorites in question, are dark purplish-red conglomerates, holding green and dark purplish-red slaty pebbles, which dip beneath a small bed of red and dark brown semi-crystalline feldspathic rock, which approaches in character a feldspar-porphyry. This latter is in turn overlaid by a conglomerate chiefly made up of pebbles of green and red felsite, similar to those described in connection with the Huronian series as forming many of the hills bordering the shores of Passamaquoddy and Cobscook Bays. Their dip is apparently S. 70° < E. 20°. Dennyville;

Upper Silurian of Oak Bay and Vicinity.

This second region of Upper Silurian sediments embraces portions of the triangular area separating Oak Bay from Waweig Inlet, (both arms of the estuary of the St. Croix River) and a part of the region to the northward of them. The extent of the area thus occupied is not definitely known, much of the country in this vicinity being flat and covered with surface-deposits, but it is probable that isolated areas of such rocks may be found along the entire northern flank of the crystalline hills which bound them on the south, and may thus connect with the Upper Silurian rocks occupying a similar position in Queen's County.

About the shores of Oak Bay and Waweig Inlet these rocks appear to embrace three members and perhaps a fourth, as follows :—

1. Purplish-grey and grey fine grained feldspathic rocks, with thin beds of conglomerate. The former hold scattered shells of the genera *Orthis* and *Rhynchonella*, and are traversed by calcareous bands, holding in addition to the above, *Strophomena rhomboidalis*, Wahl. and fragments of crinoidal columns. Section.
2. Hard grey shales holding *Orthis* and *Rhynchonella* (similar to the above) *Nuculites*, *Orthoceratites (?)* and remains of land plants (?) of undetermined genera.
3. Dark grey and black petrosilex and diorite, holding *Orthis*, *Rhynchonella* (two species), *Nuculites*, and several genera not determinable.

The strata above described have, along the eastern shore of Oak Bay,

a nearly uniform southerly dip of 60°, and unless repeated by faulting are of considerable thickness, their breadth at the surface being not less than half a mile. Mr. Billings, by whom the above fossils have been determined, is disposed to regard them as Upper Silurian, but considers the forms so far collected as insufficient to establish definitely the horizon to which they belong.

The strata alluded to above as possibly forming a fourth division of the Upper Silurian series in this region, occupy a position beneath those already enumerated, being found chiefly about the head of Oak Bay. They comprise a series of highly feldspathic rocks, which towards the base are silicious, and include numerous thin beds of fine grey quartzite, with some petrosilex and diorite. We have found no fossils in these lower rocks, but they are conformable to the fossiliferous beds above mentioned, having a southerly dip of 60°, and appear to constitute a portion of the same series. Towards the head of the bay these feldspathic and silicious rocks, including some thin beds of dark grey and black slate, are found to rest upon a thick mass of grey silicious conglomerate, composed of elongated pebbles of grey petrosilex and quartzite, which intervene between them and a mass of black finely bedded rusty and carbonaceous shales. Both here and on Roger's Island, a high bluff in the middle of the bay, where the same beds are repeated by faulting, these conglomerates have a similar southerly dip, and appear to be intimately connected with the silicious beds first mentioned; but further west, on the other side of the bay, where the conglomerates are again met with, the associated strata are mostly wanting or concealed, the conglomerates, with some slates, being the only strata visible. In this direction they may be traced in a series of low ridges curving around by the head of Pagan's Cove to the St. Croix River, crossing into the state of Maine, about three miles below Calais Bridge. Here the black shales are again wanting, the conglomerates dipping towards a mass of grey granites on the south, and being followed on the north by a series of mica-slates and imperfect gneisses belonging to the older mica-schist formation of northern Charlotte. The black shales in question are the same as those alluded to and described in an earlier section in connection with the rocks of the St. John group. They resemble these latter very nearly, but it is also possible that they may be the equivalents of the similar beds met with in the lower part of the Upper Silurian series on the Nerepis River, to be presently noticed. The contact of these shales with the overlying conglomerate has been made the subject of remark in the section last alluded to.

Conglomerate.

Upper Silurian of King's County.

The rocks of this age, alluded to in the general remarks as occurring on the Nerepis River, may be seen along the Fredericton post-road south of

Eagle Cliff, and among the hills which border the same thoroughfare on the west, between the last named eminence and McKenzie's Inn, near Nerepis station on the European and North American railway. Their width in this interval is 7,000 feet, representing an apparent thickness of about 5,700 feet, although this estimate may be exaggerated by undiscovered faults. The relations of the beds between the points named will appear from the following section :— Eagle Cliff.

Section.

	Feet
Fine grained dark reddish-grey felsite. Dip of joints (?) 70°.	
[To the north, about one hundred yards below a bend in the road known as the Oxbow, this felsite appears to graduate into a bright red syenite, the latter being connected with the great mass of granite composing the Nerepis range. The felsite, which is crystalline in the lower part, becomes paler in color and fine grained or impalpable in the upper. Its thickness (including 500 feet in which the measures are concealed,) is	1,600
Grey fossiliferous slates and hardened shale, holding shells of the genera *Orthis*, *Rhynchonella*, *Anatinella* and *Pterinea* ; dip. 60°. Thickness	100
Dark grey felsite and dioritic felsite	150
Dark grey fossiliferous petrosilicious beds, with *Discina*, *Spirifera*, *Orthis*, *Rhynchonella* and *Bellerophon*. At the base are paler and more sandy layers holding *Pterinea*, etc., dip 60°	80
Measures concealed by a gravel terrace, but, supposed to be hard silicious beds	1,350
Measures concealed on the post-road ; but up a small stream (Cunningham's Brook) which here joins the Nerepis, the strata occupying this space were found to be grey and dark grey petrosilicious slates, holding *Orthis*, *Athyris*, *Rhynchonella* and plant remains. These slates alternate with dark fissile carbonaceous shales, of which some beds are crowded with a peculiar spore-case or carpolite (?) Dip 60° ; thickness	670
These are surmounted by other silicious slates. Dip as above	310
Space occupied chiefly by diorites	100
The measures (silicious slates) are then concealed for a space, representing a thickness of about	120
Fine grey slate-conglomerate then succeeds and is covered by grey petrosilicious beds, with remains of small gasteropods. Dip 60°	60
A space of one thousand feet then occurs, in which there are no exposures on the post-road, except at the southern end, where black carbonaceous slates and pale grey silicious or feldspathic rocks are exposed in the bed of a brook (Nace's Brook) ; but opposite this interval to the westward are wooded hills, composed of black and dark grey petrosilicious beds, with pyrites disseminated and in veins	970
	5,690

Throughout this section the dip of the rocks is comparatively constant, being 10° to the west of south. About two miles west of this line the slates terminate against a granite plateau, which extends thence in a southerly direction nearly to Loch Alva, on the East Musquash River, cutting off this basin

of Silurian rocks from those in the southern part of Charlotte County. The boundary between the slate and granite country is roughly marked by the depression through which the Brittain stream flows to its embouchure in the lake alluded to.

In the district immediately to the eastward of the Nerepis River, and south of the granite hills, the Upper Silurian strata are less fully exposed than in the area above described. At several points, however, within the valley which here intervenes between the crystalline belt and the low range of Huronian hills bordering the Long Reach of the St. John River on the north, fine grained slaty and petrosilicious rocks containing scattered fragments of encrinal joints and ribbed shells, were met with, and were found to be continuous with a larger mass of such strata, more highly charged with fossils, which occur along the course and about the embouchure of Jones's Creek, three miles west of Oak Point. From this place the strata in question spread widely, in low undulations, both to the east and north, filling depressions among the older hills of Huronian rock described in earlier pages as occurring in this region, and connecting with the similar Silurian rocks on the northern side of the granite hills.

Jones' Creek. The best exposures of these fossiliferous sediments are to be found near where the road running along the north side of the Long Reach crosses the mouth of Jones's Creek. At the bridge over this stream and for several rods to the south, the rocks exposed along the road-side are rather soft grey and dark grey shales, dipping S. < 70°. From these beds the following fossils, determined by Mr. Billings, were obtained:—crinoidal joints; *Chonetes Nova-Scotica*, Hall; *Orthis*, allied to *O. planoconvexa*, Hall; *Rhynchonella*,— ?; *Spirifera*, allied to and probably identical with *S. cristata*, Linne; *Cleidophorus elongatus*, Hall; *Lingula*,—— ?; *Nuculites*,—— ?; *Pterinea*,—— probably new; *Homalonotus Dawsoni*, Hall; *Phacops*,—— ?; and several species of encephala not determinable generically. To the southward of these beds, shales similar to the above, but less fossiliferous, include one or more beds of diorite, beyond which, towards the Reach, the rocks are dioritic sandstones and petrosilicious beds, probably of Huronian age. On descending in the series in the opposite direction, the shales at the bridge are found to be underlaid by harder beds, which are but sparingly fossiliferous, and which consist of hard grey petrosilex, in some parts approaching a quartzite. With these beds, which nearly resemble those seen on the Fredericton road south of Eagle Cliff, are beds of interstratified diorite.

Fossils.

Throughout the series above described, the dip of the rocks, which have a surface breadth of about half-a-mile, is uniformly southerly, but in passing over the hills to the north and east of Jones's Creek, this dip becomes reversed, the fossiliferous shales re-appearing with a northerly inclination (N. < 60°). The anticlinal ridge thus indicated extends to the eastward in the rear of the settlement for a considerable distance, and probably towards

the head of the Reach, fossiliferous shales and petrosilex having a northerly dip, being visible at several points to the eastward of Oak Point, and along the shore of Mistake Cove. Both here and near Jones's Creek, they dip towards heavy masses of coarsely crystalline diorite (connected between the points named by more or less continuous ridges of similar character), which may be a part of the same series, but are more probably of Laurentian age, being in some parts porphyritic with crystals of white feldspar, and containing grains of magnetic iron.

In passing to the northward from Jones's Creek towards Jerusalem Settlement by either of the roads which connect these two localities, Upper Silurian schistose rocks are met with at various points, occupying depressions between hills composed of the diorites last mentioned, or of Huronian felsites. Among the strata met with on the more westerly of these two roads, which passes to Jerusalem by way of Broke-neck Mountain, are beds of hard grey conglomerate, containing large rounded pebbles, from one inch to one foot in diameter, of grey flinty petrosilex, which probably belong to the series under consideration. They occur at the distance of about a mile from the mouth of Jones's Creek, and a little to the northward of a series of soft shales, some of whose layers are filled with small shells and crinoidal columns. Beyond these conglomerates, the rocks exposed along this road, as far as the county-line, are mostly felsites and felsite-conglomerates, of grey and dark purplish-grey colors, which are partly of Huronian age, but near the boundary in question, where a small brook flows from Murphy's Lake, hard bluish-grey slates, holding a few obscure fossils, were met with in nearly horizontal beds. Similar strata outcrop at one or two places between the county-line and Broke-neck Mountain, as well as about the base of the latter, but are not so well seen here as about three miles to the eastward. on the second of the two roads alluded to above, where this latter passes beneath Blue Mountain, at the eastern termination of the Broke-neck ridge. From the hard grey fossiliferous shales exposed at this point, the following organic remains, determined by Mr. Billings, have been obtained; species of *Orthis*, *Strophomena*, *Chonetes*, *Spirifer*, *Rhynchonella*, *Pterinea*, *Modiolopsis*, *Platyostoma* and *Orthoceras*, with crinoidal joints. The strata in question, which cover a considerable area, have in some parts a marked inclination, but are for the most part nearly horizontal, dipping S. 35° W. < 15°. They are divided by cleavage-planes nearly at right angles to those of the bedding (dip S. 10° W. < 80°). The pressure resulting in this cleavage is still further manifest in the condition of the shells, which are, with few exceptions, compressed in a direction parallel to the cleavage, and so highly distorted as not to be specifically determinable.

Blue Mountain.

Fossils.

In passing around the shores of Long Lake, which lies in a depression a little to the eastward of Blue Mountain, between the latter and the hills of crystalline rock which come into view at Fannen's Lake, strata resembling

those of the Upper Silurian series were met with at several points, but the broken ridges occurring here being wholly uncleared, the relations of these to each other and to the associated strata, could not be determined. Among the latter are heavy beds of diorite, some of which contain magnetic iron, together with considerable masses of dark grey, porphyritic petrosilex, weathering greenish-grey, and conglomerate, resembling some portions of the Huronian series. Near the foot of the lake (between the latter and Blue Mountain), are high bluffs, in which a somewhat similar rock, being a hard greenish-grey grit, may be seen interstratified with grey slates not distinguishable from the fossiliferous beds described above, both dipping northerly at a moderate angle (30°).

The Upper Silurian rocks which occur along the northern side of the hilly region above described, near the boundary between King's and Queen's Counties, present features for the most part similar to those of the same age on the southern side of the crystalline belt. Between Blue and Broke-neck Mountains, along the road which connects these two hills south of Jerusalem Settlement, the rocks are mostly hard grey fine grained clay-slates, similar to those about the last named eminence. From Broke-neck Mountain a belt of Upper Silurian sediments, about three miles in width, extends to the westward along either side of the George Lyon road to the valley of the Nerepis River below Armstrong's Corners, and thence through the Nerepis valley nearly to Douglas Mountain. As elsewhere through the region under consideration, they occupy depressions among ridges of older crystalline rocks, some of which are of Laurentian and others of Huronian age. They include also heavy beds of diorite, usually less coarsely crystalline than those generally met with in the first named system. At Fowler's Falls on the Nerepis River (about three miles above Welsford village), the Upper Silurian rocks are dark grey bluish-weathering petrosilicious beds, dipping S. 30° E. $<$ 50°, the strong slaty cleavage having an underlie of N. 10° E. $<$ 50°. To the south, in Hardscrabble Settlement, and to the southwest along the southern side of Nerepis valley, the rocks are hard dark grey and very feldspathic quartzites, weathering with a slightly purplish tinge, and associated with numerous beds of coarsely crystalline diorite, holding comparatively little feldspar. A good view of these strata may be had on a stream which flows southwardly from the range of Laurentian grey granites which overlook the Nerepis valley opposite Douglas Mountain. Their thickness must be great, seeing that they form the whole northern face of a terrace several hundred feet in height, having a very regular southward dip of 60°, and occur at intervals, with a similar dip, for half a mile back from their first described outcrops. At the rear of this terrace, which is about a mile in breadth, similar quartzites may be seen along the northern flank of the granite hills which, at this point, rise abruptly to a much greater elevation; here they are somewhat gneissoid, resembling a rock holding a similar

Nerepis valley

position on Fannen's Brook, in the parish of Hampstead, which is there intersected by veins of red intrusive granite. At the foot of these same granite hills in the Nerepis valley are numerous fragments of pale red granular felsite, which are also similar to beds met with near the granite on the lower part of Fannen's Brook. We have not met with any fossils in the silicious beds now under review, but at several points in Hardscrabble Settlement, remains of *Orthis* and *Rhynchonella* were observed in hard fine grained purplish-black feldspathic sandstones, which are probably a part of the same belt, and in close proximity to beds of diorite.

DEVONIAN SERIES.

A general view of the character and relations of the Devonian rocks as seen in the vicinity of the city of St. John, has been given in the Introduction to this Report, together with references to the various publications in which the rocks in question and their interesting organic remains have been discussed. We present here a condensed summary, including the results of recent investigations.

When the attempt was first made to arrange the Devonian rocks about St. John, those from which fossil plants had been obtained were associated together under the name of the Little-River group, including two sub-divisions, of which the lower (Dadoxylon sandstone) was found to consist mainly of sandstones and grits of a nearly uniform pale grey color, with some dark grey shales, and containing the more prolific plant-beds; and the upper (Cordaite shales) of schistose rocks of grey, olive-green, and red colors, (with some conglomerates,) and but sparingly fossiliferous. With these latter were also doubtfully associated a series of highly altered rocks, consisting of granulite or granitic sandstone, micaceous slate, chloritic schists, etc., found resting upon the Dadoxylon sandstone along the coast near Black River, eastward of St. John, which in the present Report are described in connection with the Huronian series. Below the Little-River group on the one hand, the Bloomsbury group was found, and above it on the other, the Mispec group; the former consisting to a great extent of dioritic and trappean rocks capped by **History.**

red slates and conglomerates, and at several points seen to intervene between the Dadoxylon sandstone and the St. John Lower Silurian slates, and the latter of clay-slates of red and purple colors, and coarse conglomerates, overlying the Cordaite shales. Neither the Bloomsbury nor the Mispec group was found to be fossiliferous.

At the time that the above arrangement was proposed, no knowledge was possessed of the great system of faults and overturns now known to have affected the region in which these rocks are found. It having been rendered probable, however, from a study of these faults, in connection with further observations upon the series thus affected, that much of what had previously been referred to the Bloomsbury group is in reality of Huronian age, a separation of the latter from the Devonian beds became necessary, as shown in preceding pages. As thus limited, the Devonian rocks of St. John County present the following arrangement.

Synopsis.

BLOOMSBURY CONGLOMERATE; a coarse rock, reddish-grey in color, and having beds of red slate interstratified; thickness 500 feet.

DADOXYLON SANDSTONE; grey sandstone and grit, with beds of dark grey shale, sometimes graphitic. Thickness, 2,800 feet. Fossils: numerous plants, several crustaceans, wings of insects.

CORDAITE SHALES AND FLAGS; green and red argillites and dark grey shales; reddish and grey sandstones, grits and conglomerates alternating with the argillaceous beds; pale olive-green flags and shales, with partings of dark grey shale Estimated thickness, 2,400 feet. Fossils: *Cordaites, Calamites, Stigmaria*, ferns, &c., for the most part identical with those of the Dadoxylon sandstone.

MISPEC CONGLOMERATE; red conglomerates and argillites Thickness, 1,800 feet.

Of these groups, the Dadoxylon sandstone has been traced westward of the St. John River to Lepreau Harbor near the eastern border of Charlotte County, but in the opposite direction appears to be of more limited extent, not having been observed eastward of the settlement at the mouth of Black River. Near Lepreau, these sandstones rest against Laurentian gneiss, and are apparently covered by a belt of red and green slates, sandstones and some conglomerates, which intervene between them and a thick series of felsites of grey and greenish-grey colors, extending along the coast from Dipper Harbor.

Laurentian gneiss divides the Devonian rocks in the western part of St. John County from those about the harbor of St. John. These are first seen in the western side of the harbor, in the town of Carleton. Here, where the most prolific plant-beds have been found, they rest upon overturned Huronian strata (formerly referred to the Bloomsbury group), and are overlaid by the Cordaite shales. A similar relation is observable on the eastern side

of the same harbor; but here, by another fold of the strata, they take the form of a trough or synclinal basin opening to the southwest. The centre of this basin is occupied by the Cordaite shales and Mispec rocks, unconformably overlaid by an outlier of Lower Carboniferous conglomerates.

Folding over the ridge of Huronian strata which forms the southern border of this depression, the sandstones are again seen between the latter and the Bay of Fundy, extending eastwardly beyond Black River. From the waters of the Bay they are here separated by the series of metamorphic strata described in a previous part of this Report as the Coastal group of Huronian rocks; these overlie the Dadoxylon sandstones.

DETAILS OF THE DEVONIAN SERIES.

At the base of the Devonian series, in the vicinity of the city of St. John, are red slates and conglomerates described in previous publications as forming the upper member of the Bloomsbury group. In the town of Carleton, on the western side of St. John Harbor, these red rocks are not seen, being cut off by a fault, which brings the heavy beds of diorite of Carleton Heights against a series of hard grey sandstones, to which, from their most characteristic fossil, the term Dadoxylon sandstones has hitherto been applied. It is from these latter, and from associated thinner beds of dark grey shale, which skirt the shore for some distance west of the town of Carleton, that the greater part of the organic remains of this series has been obtained.

In an appendix to our Report to the Provincial Legislature in 1865, Section.
an elaborate section of these Devonian rocks was furnished by Professor C. F. Hartt, together with a list of the several species of organic remains found therein, and remarks on their mode of occurrence. More recently, the same section, in a modified form, has been re-produced in the second edition of Dr. Dawson's Acadian Geology, together with full descriptions and illustrations of both the animal and vegetable fossils yielded by the beds. In the same work, the author last mentioned has given the results of his study of the Devonian flora of St. John, as compared with that of New York, Maine, Gaspé, and Europe.*

We append here a list of all the organic remains so far obtained from the Devonian strata of this vicinity, and described in the work referred to :—

*See farther, under the description of the Perry sandstone, a note relating to Dr. Dawson's last publication on the subject.

ANIMALS.

Devonian fauna.

Insects :

Platephemera antiqua. *Scudder.*
Homothetus fossilis. *Scudder.*
Dyscritis vetustus. *Scudder.*
Lithentomum Hartii. *Scudder.*
Xenoneura antiquorum. *Scudder.*
Gerephemera simplex. *Scudder.*

Crustaceans. :

Eurypterus pulicaris. *Salter.*
Amphipeltis paradoxus. *Salter.*

Worms :

Spirorbis sp. ?

PLANTS.

Devonian flora

Dadoxylon Ouangondianum. *Dawson.*
Sigillaria palpebra. *Dawson.*
Stigmaria ficoides (var.) *Brongn.*
Calamites transitionis. *Goeppert.*
——— cannæformis. *Brongn.*
Asterophyllites acicularis. *Dawson.*
——— latifolia. *Dawson.*
——— scutigera. *Dawson.*
——— longifolia. *Brongn.*
——— parvula. *Dawson.*
——— laxa. *Dawson.*
Annularia acuminata. *Dawson.*
Sphenophyllum antiquum. *Dawson.*
Pinnularia dispalans. *Dawson.*
Lepidodendron Gaspianum. *Dawson.*
Lycopodites Matthewi. *Dawson.*
Psilophyton elegans. *Dawson.*
——— glabrum. *Dawson.*
Cordaites Robbii. *Dawson.*
——— angustifolia. *Dawson.*
Cyclopteris Jacksoni. *Dawson.*
——— obtusa. *Goeppert.*
——— varia. *Dawson.*
——— valida. *Dawson.*
——— Bockshiana. *Goeppert.*
Neuropteris Dawsoni. *Hartt.*

Neuropteris polymorpha. *Dawson.*
———— sp. nov.
———— probably two other species.
Sphenopteris Hœninghausi. *Brongn.*
———— marginata. *Dawson.*
———— Hartii. *Dawson.*
———— Hitchcockiana. *Dawson.*
———— pilosa. *Dawson.*
Hymenophyllites Gersdorffii. *Goeppert.*
———— obtusilobus. *Goeppert.*
———— curtilobus. *Dawson.*
———— subfurcatus. *Dawson.*
Pecopteris (Alethopteris) discrepans. *Dawson.*
———— ———— ingens. *Dawson.*
———— ———— obscura (?) *Lesq.*
———— preciosa. *Hartt.*
———— Perleyi. *Hartt.*
———— serrulata. *Hartt.*
Trichomanites sp. (?)
Cardiocarpum cornutum. *Dawson.*
———— obliquum. *Dawson.*
———— Crampii. *Hartt.*
———— Baileyi. *Dawson.*
Trigonocarpum racemosum. *Dawson.*
Antholithes Devonicus. *Dawson.*

Eastward of Duck Cove, on the Carleton shore, from which the majority of the fossils above enumerated were obtained, the strata have a course about N. 80° W., with a southerly or seaward dip of about 45°. As noted by Professor Hartt, their entire thickness, measured from the underlying Huronian strata to where they pass beneath the waters of the bay, is 444 feet 11 inches; of which the first 300 feet consist mainly of hard grey sandstones and flags, containing numerous trunks of the genus *Dadoxylon.* In the remaining thickness of 144 feet 11 inches, no less than eight plant-beds have been recognized, consisting of thin beds of arenaceous and argillaceous shale interstratified with grey sandstones. These shales are usually of fine texture and of a dark grey color, sometimes greenish-grey or black, the darker beds being especially rich in plant-remains, which are finely preserved on the surfaces of the slates in lustrous films of graphite. **Duck Cove**

Westward of Duck Cove a few ledges of sandstone and shale are exposed, in which, however, the plant-remains are not so numerous. At Sand Cove these ledges are covered by Post-pliocene beds, which conceal the subjacent rocks for many miles to the westward.

The above fossiliferous rocks are included in the Dadoxylon sandstone.

No higher beds appear along this shore, but they come into view in ledges visible at low tide, in the city of St. John, and again eastward of the latter, in the parish of Simonds, where they are prominantly displayed for some miles along the coast, and inland between the valley of Little River and that of the Mispec. On the coast-line between these two streams, the shales towards the base of the Cordaite shales and flags present tolerably well preserved remains of plants of the following species;—*Cordaites Robbii, Calamites transitionis, C. cannaeformis, Psilophyton glabrum, Asterophyllites latifolia, Neuropteris polymorpha, Neuropteris* n. sp., *Pecopteris discrepans, Pecopteris* n. sp., like *P. Serlii, Schizopteris* and other ferns. Higher beds in the same vicinity yield *Stigmaria ficoides* and *Psilophyton glabrum.*

Little River.

The northern limit of the Devonian rocks in the eastern part of St. John County, may be traced from Carleton Heights across the harbor of St. John, through the southern part of the city of that name. They are removed from view by denudation at Courtney Bay, but re-appear on the north side of Little River, and thence, crossing this stream, extend for several miles along the Lower Loch Lomond road. Near Loch Lomond they are concealed by superficial deposits, but again rise into view westward of Black River near Bloomsbury Mountain. From this point they extend in a southerly direction to Milligan's (Millicent) Lake, in the rear of the Mispec. At this lake the course of the beds is changed again, for they now trend away to the northeast, cross Black River, and meet the Bloomsbury or Quaco Hills on the southern side.

Between Courtney Bay and Loch Lomond the dip of the Lepreau rocks is southeasterly, but it is reversed in the valley of the Mispec, when the same beds dip westerly, northwest, and west-northwest, as they approach Port Simonds. In the synclinal valley thus indicated, are contained the higher Devonian rocks, unconformably overlaid, near the centre of the basin, by red conglomerates of the Lower Carboniferous formation.

Mount Prospect.

At Mount Prospect, about four miles east of the city of St. John, an excellent exposure of the whole of the Dadoxylon sandstone and the greater part of the Cordaite shales and flags may be seen, where these rise from beneath the Post-pliocene gravel of Little River valley*. The sandstones exposed at this point do not differ from those seen at Carleton and St. John, having at intervals beds of grit and dark grey shale, with an aggregate thickness of 2,000 feet. They contain imperfect remains of land-plants, among which may be recognized *Calamites transitionis* and stems containing discigerous tissues in which the pores are arranged in pairs.

By an increase in the bulk and frequency of the finer beds, the Dadoxylon sandstones gradually pass into the flags and shales of pale olive-green and red colors at the base of the Cordaite group. These frequently alternate

*The description of the beds in this vicinity is mainly taken from Mr. Matthew's Paper on the Geology of St. John County.

with reddish and grey sandstone and grit; the latter predominating east of this place, while flags and shales are more prevalent in the western extension of the deposit. *Cordaites Robbii* has been found to characterize these shales throughout nearly their whole thickness of twenty-three hundred feet; while from their upper beds the cephalic shield of a trilobite has also been obtained. Some of the coarser flags are more or less charged with carbonate of iron, which gives a buff color to weathered surfaces. They cover an extensive area in the valley of Mispec River, owing principally to a secondary fold of the strata. In the same valley the thickness of the underlying Dadoxylon sandstone is much greater than at Little River, being apparently thirty-six hundred feet. The dark shales accompanying the latter have here, as at other points in this basin, fossil plants similar to those of Carleton, but they are less abundant and in a less perfect state of preservation than at the last named locality.

Cordiate flags, etc.

The highest Devonian beds in the basin under consideration are those described in previous publications under the name of the Mispec group. They consist of coarse reddish conglomerates, holding fragments of grey petrosilex, reddish sandstone and a few pieces of impure slaty limestone, imbedded in a red slaty paste. These fragments resemble certain Huronian rocks of the Coastal group at Black River, etc. The conglomerate is overlaid by thick beds of purple clay-slate, which, by the accession of coarser materials, becomes a slaty sandstone and grit filled with white kaolinized feldspar. Above this is a slaty conglomerate holding fragments of slate and sandstone. The dip of the rocks in the lower part of the Mispec group diminishes rapidly from 30° to 15°.

Mispec group.

Near the mouth of Black River the Dadoxylon sandstone and overlying conglomerate and red argillite are well exposed. The former crosses the stream just at the mouth of the east branch, and at that point contains fragments of trees and other plant-remains. The conglomerate may also be seen further east on the road from Loch Lomond to Emerson's Creek.

The Devonian rocks in the western part of St. John County occupy isolated areas of greater or less extent, resting upon the Laurentian and Huronian rocks, which form the larger part of the parish of Lancaster, and have been traced in this direction to Lepreau Harbor in the eastern part of the county of Charlotte.

Lancaster.

For several miles to the westward of the town of Carleton the older rocks are for the most part hidden from view by heavy deposits of Post-pliocene clays and gravels. Those which do rise to the surface at Sheldon's Point and Taylor's Island are of Huronian age. Farther west, in the depression now occupied by Spruce Lake, are patches of coarse bright red quartzose conglomerates and red sandstones, which rest unconformably upon Laurentian gneiss and have (at the eastern end of the lake), a dip S. 30° E. $< 80°$. These rocks closely resemble some of those occurring about Musquash Harbor and

River, to be presently described, with which they appear to be connected through small outliers exposed along the southern shore of Spruce Lake and on the line of the post-road to St. Andrew's. They are probably of the same age as the red sediments beneath the Dadoxylon sandstones at Musquash Settlement.

Lancaster. The village of Lancaster is scattered along the northern side of a salt marsh about three and a half miles long and two wide, shut off from the sea by a ridge of Laurentian gneiss which crosses the Musquash River at the Narrows. This marsh is parted into two nearly equal portions by Diamond Hill, an elevation consisting chiefly of the red conglomerate and argillite which underlie the Dadoxylon sandstone. The sandstone in question may be seen outcropping along the low hills which border the marsh on the southern side, and about a mile up from the Narrows has a dip of S. 20° W. < 80. In the constriction of the marsh at Diamond Hill the same arenaceous group may be seen, crossing the stream from the southern base of that hill. The beds here dip southwardly at an angle of 60°. For two miles from this point they are concealed from view by deposits of Post-pliocene clay and marine alluvium; but they emerge again from beneath these superficial deposits at the head of the marsh, forming ledges around the Roman Catholic chapel, near the house of P. Byrne, and at the mill on the west branch of the Musquash River, Westward of this the Dadoxylon sandstone is crossed diagonally by a "horse back" or gravel-ridge along which the post-road to St. Andrew's runs for some miles. South of this ridge, ledges of the same rock, with some conglomerate, appear on the road leading to Dipper Harbor, for nearly half a mile southward of its junction with the post-road, apparently dipping S. 30° E < 60°. In this direction, after a small interval, they are followed by purplish-red argillites and conglomerates, which intervene between them and a body of feldsphatic and petrosilicious rocks, described in connection with the Coastal group, the first of a succesion of such beds occupying most of the space between this point and Dipper Harbor.

Westward of the Dipper-Harbor road the rocks are much obscured by woods and surface-deposits, but near Lepreau Basin the Dadoxylon sandstones come again into view, as well as about the mouth of Little Lepreau River. Throughout this district the dip is very irregular and the beds are much faulted and folded. One displacement, just beyond the last named stream, brings these sandstones into view so far to the north that the lowest beds here are two thousand feet north of the highest beds on the river-side.

Lepreau. A peninsula about a mile wide seperates Lepreau Harbor from Lepreau Basin, and on its long coast-line gives good exposures of the Dadoxylon sandstones and the lower part of the Cordaite shales, no other portion of the series being present here. Near Lepreau Basin indications of Devonian vegetation are common, and in some of the shale-beds well preserved plants occur, among them a pinnule of *Neuropteris* of large size. One bed especially

seems to be the counterpart of the principal plant-beds of the Fern Ledges near St. John, containing as it does a large number of similar ferns and other plant-remains, and being in like manner covered by a layer marked with impressions of rain-drops. The following is a complete list, prepared by Fossils.
Dr. Dawson, of the fossils occurring at this locality :—*Neuropteris retrorquata*, n. s. Dawson, ; *N. polymorpha*, Dawson ; *Alethopteris discrepans*, Dawson ; *Cordaites Robbii*, Dawson ; *Hymenophyllites Hildrethi*, Lesq ; *Pecopteris* ——? new ; *Asterophyllites acicularis*, Dawson ; *Calamites transitionis*, Goeppert ; *Calamodendron antiquius*, new species ; *Calamodendron tenuistriatum*, new species ; *Calamites cannaeformis* ; *Sternbergia* ; *Dadoxylon Ouangondianum* ; *Cardiocarpum cornutum*, Dawson ; *C. Crampii*, Dawson ; *Cordaites Robbii*, Dawson ; *Asterophyllites* ; *Antholithes Devonicus*, Dawson ; *Sphenopteris pilosa?* Dawson ; *Psilophyton*, spore-case ; *Cordaites angustifolius?* Dawson ; *Sphenophyllum*.

At the side of Lepreau Harbor, the sandstones abound with groups of trees, filling cavities in the rocks, occasionally three feet in diameter and twenty feet long. *Calamites transitionis* and *Sternbergia*, were also met with here in the sandstone beds. Near Hanson's mill, at the mouth of Little Lepreau River, the grey Dadoxylon sandstones, with some grey conglomerate, overlie grey slaty sandstones and dark grey shales. The dip of these beds at the mills is N. < 50°, but they are much broken, and a little to the south, on the shore of the northern arm of Lepreau Basin, show an anticlinal, the dip becoming S. < 70°. On the southern shore of the same arm, and not more than twenty rods from the beds last named, are ledges of bright red shaly sandstones, standing vertically, with an easterly course. Similar red shales and purplish-red conglomerates form the greater part of the peninsula between the two arms of Lepreau Basin, and are well exposed along the road connecting these latter, a short distance eastward of Hanson's mill. They here dip S. 20° W. < 70°, and are the same as those described in connection with the Coastal group of rocks as occurring just north of the Dadoxylon sandstones in the village of Lancaster. Between these red argillites and the shores of the southern arm of Lepreau Basin, grey sandstones, not distinguishable from those about Little Lepreau River, come into view. Like those last named, they include beds of soft fissile grey shales and greenish-grey shales, the dip in some portions being quite irregular with numerous folds, but where most uniform, N. 70° W. < 40°. In Black Duck Hole, which forms an indentation on the northern side of the same arm of Lepreau Basin, the dip of the beds is N. 30° W. < 20°, the lower beds being mostly shales of a greenish color, which toward the head of the same indentation dip beneath the grey sandstones, some of the latter here showing a banded appearance. Similar sandstones and shales form the entire northern shore of Lepreau Basin to its eastern extremity, but at this point grey shales, apparently of the same series and with a low

southwesterly dip (S. 40° W. < 30°), are directly overlaid by purple-red sandstones, having the same dip. These are apparently connected with a series of purple-red quartzose conglomerates and arenaceous slates, which form the hills on the opposite or southern side of Lepreau Basin, where they expose a surface-breadth of over one thousand feet, with a dip N. 10° E. < 80°, gradually declining to N. < 50°.

FAULTS AND DISLOCATIONS.

Over the greater part of southern New Brunswick, the paleozoic strata older than the Lower Carboniferous and Perry rocks, were generally found to be inclined at very high angles. There is, however, a remarkable exception to this nearly vertical position of the beds, in a belt of country extending from Blue Mountain in Queen's County to Passamaquoddy Bay in Charlotte County, where it has a considerable width.

Attitude of strata.

At several points along this belt, areas of old gneissic rocks, generally inclined at high angles, are exposed by denudation of the incumbent strata. Where we have examined these latter we have seldom found them to be inclined, except for very short distances, at a higher angle than 40°, and very often not more than 10° or 20°. In the western part of Charlotte County this tract of horizontal and moderately inclined sediments extends on the northwest to the vicinity of St. Stephen and the Roix road in the parish of St. Patrick, and on the southeast is limited by the highly inclined strata of the group of islands which divides Passamaquoddy Bay from the Bay of Fundy, and their continuation in the Mascarene peninsula. In the northeast corner of Charlotte County, on the west branch of the Musquash River, on the Nerepis River, and on Back Creek, a branch of the South Oromocto stream, the planes of lamination in the intrusive granites are also inclined at low angles. Still farther east, at Blue Mountain in Queen's County, the Silurian strata are in like manner moderately inclined.

Along its southern side this stable belt is bordered at Passamaquoddy Bay by schists and slates of the Kingston group, which are nearly vertical, or highly inclined to the southeast; at New River by Upper Silurian strata and Huronian beds of the Coastal group, highly inclined and dipping southwardly; at the west branch of the Musquash River, by schistose beds of the Kingston group, having a like inclination; and on the Nerepis River by Silurian and Huronian strata, similar to those of New River, also inclined to the southward at high angles. On the north side of the granite belt at the Nerepis River, the slates are overturned about 10°, and in Clarendon are nearly or quite vertical; but in the parish of St. Patrick, along the western part of

the belt of moderately inclined strata, and on its northern side, the argillites and quartzites are thrown into low undulations parallel to it.

The slaty cleavage in the Upper Silurian and the argillite strata covering a part of this tract, is nearly or quite vertical, the course of the cleavage-planes being parallel to the longer axis of the tract of moderately inclined strata, (which is also that of the crystalline belt of this region alluded to in a previous part of the Report), and cutting directly across the basset edges of the beds of this series where they run at an angle with the course of the crystalline belt. Slaty cleavage.

On the south side of this tract, the cleavage-planes have an underlie to the southeast of from 60° to 80°; on the north side, in the Nerepis country, it is at first vertical, but decreases gradually to a northerly underlie of 40° or 50° at the distance of a few miles from the granite, although the sedimentary layers are vertical. On Back Creek, where the argillites are light greenish-grey, sandy and highly micaceous, the spangles of mica are mostly parallel to the planes of cleavage, causing the slate to split more readily in the direction of the cleavage than in that of the sedimentary layers.

Between the belt of moderately inclined strata extending from Passamaquoddy Bay to Blue Mountain and the Bay of Fundy, the Upper Silurian, Devonian and older rocks are generally tilted up at a high angle. There are, however, several exceptions to this rule, among which may be enumerated a part of the Kingston strata at New River, portions of the Laurentian at Musquash Harbor, and the rocks of the Coastal group at Lepreau Basin and L'Etang. The latter are often moderately inclined (from 40° to 20°), when Upper Silurian and Devonian strata close at hand are nearly vertical. So also the dip of the beds in the Cordaite and Mispec groups in St. John County, varies from 40° to 20°, when that of the Dadoxylon sandstone in their neighborhood is 60° or more.

The highly disturbed tract intervening between the granite belt of Charlotte County and the coast, is divided longitudinally by a number of great faults associated with marked dislocations of the strata, having usually an underlie of 70° or 80° to the southeast, and a southwest and northeast course. Beginning at the shore of the Bay of Fundy, southeast of St. John, there is a fault extending northeast from Cape Spencer to the rear of the Black River Settlement, having Dadoxylon sandstone on the northwest side, and Huronian rocks of the Coastal type on the southeast. In the Black Settlement on Black River is a second, having slates of the St. John group on the north side, and Huronian rocks on the south, the downthrow being on the north side. On Ratcliffe's mill-stream, near Loch Lomond, is another fault having overturned Huronian on the north side, on which side the beds are let down. This is nearly on a line with one which crosses Courtney Bay and St. John Harbor, and is bordered on the southeast by Dadoxylon sandstone. The downthrow here is probably on the south side. Faults.

Just north of the city of St. John there is another important fault, extending from Golden Grove, near Loch Lomond, to the shore of the Bay of Fundy between Musquash and Little Musquash Harbors. This is flanked on the north by Laurentian and on the south by Huronian strata, to the eastward of the St. John suspension-bridge, and by the St. John group westward of that structure. Between the Kingston rocks and the Laurentian gneiss of St. John County a fault occurs, which is not obvious on the Kennebecasis, but is more evident near Lepreau village. Here the downthrow is on the north side. Another break occurs on the north side of the Kingston rocks, at the mouth of the Nerepis River in King's County, and may be continuous with a fault which exists at Deadman's Head, in Charlotte County; this is bordered on the northwest by sediments of the Coastal group, and on the south by those of the Kingston group. Still another great fault runs along the south side of Passamaquoddy Bay; it is flanked on the southeast by the lower part of the Kingston group and on the northwest by the Mascarene strata. The downthrow is on the north side.

Besides these, there are many other faults of minor importance in this district, having downthrows to the north.

This system of faults and accompanying dislocations does not appear to have affected the Lower Carboniferous strata of the eastern counties, or the Perry sandstones of the western, these sediments being spread at various points indifferently over each of the older formations, and filling up the inequalities caused by the dislocations above named.

In the valley of the Kennebecasis the conglomerates, argillites and limestones of the Lower Carboniferous series are divided by a number of faults, having an underlie to the north and a downthrow on the southern side.

INTRUSIVE GRANITES.

We have already had occasion to refer, in the earlier portion of this Report, to the great belt of crystalline and granitoid rocks, which, entering the Province at and below St. Stephen on the St. Croix River, thence extends eastwardly to the St. John River in Queen's County,—as well as to the fact that while portions of that belt bear much resemblance to the Laurentian rocks of St. John County, other large portions are more highly crystalline, homogeneous, and without the gneissic structure of the Laurentian strata,

The principal area of the rocks in question is to be found westward of the Douglas and Nerepis valleys in Queen's County, forming the axis of the Nerepis range of hills, and thence widening into a large and irregular district about the head-waters of the Oromocto, Musquash and Lepreau Rivers in King's and Charlotte Counties. Through this latter county these rocks have been traced southwesterly across the New River to Lake Utopia and the Magaguadavic River, and thence to the Digdequash River. Eastward of the Nerepis valley, they form portions of the hilly and broken country lying north of the Long Reach of the St. John River, extending from Eagle Cliff and Douglas Mountain on the Nerepis River, to the Bald Mountain ridge on the line between King's and Queen's Counties. Nerepis Hills.

As a whole, this granitic area may be said to have an irregularly lenticular form, with the longer axis extending from the Digdequash River in Charlotte County, to Bald Mountain, and having a shoulder projecting southeastwardly to Loch Alva on the East Musquash River. For a long distance on both sides of the granite hills, the crystalline rocks are in direct contact with schistose strata, which have been tilted up against them on both sides, being on the north vertical, or slightly overturned in their eastern extension, and dipping at an high angle in their western; and on the southeast side inclined against the granite at angles varying from 60° to 80°, but on the southwest side only at angles of from 20° to 40°. Thus, on its eastern end, the granite gives the character of a pinched-up synclinal to the schistose strata, but at its western becomes a broad dome, upon which the stratified deposits rest.

At the northeastern and southwestern ends of this intrusive mass, stratified deposits older than those above named, abut against it. They are best seen to the eastward, and consist of Huronian beds, the St. John group, and a mass of strata of Huronian aspect. These sediments bear very much the same relations to the granite as do those of the Upper Silurian and the argillite series. Rocks resembling those of a still older series, namely the Laurentian, are in contact with the intrusive rock at both extremities of the area in which it appears, and form the extension, both westward and eastward, of the anticlinal ridge of which the intrusive granite is a part. In both of these directions, that is to say on the west between the Digdeguash and St. Croix Rivers, and on the east in the parish of Hampstead in Queen's County, red granitoid rocks of a highly feldspathic character, and bearing much resemblance to portions of the great intrusive mass above described, are associated with these supposed Laurentian rocks, and, especially on the west, cover extensive areas. We have nowhere observed veins from the first named crystalline mass penetrating the surrounding slates, shales, and quartzites; but such veins occur in the eastern part of the parish of Hampstead in connection with the red crystalline rocks referred to above as occurring in that region. It may be further remarked that no frag- Relations to surrounding groups.

ments of the intrusive granites described above have been met with in the conglomerates of Devonian age, or those of greater antiquity, while they are quite common in the beds of the Perry group, and other parts of the Lower Carboniferous Series. This fact, together with their relations to the surrounding series, renders it probable that they were thrust through these strata at the close of the Devonian period.

Varieties. Four principal varieties of granitoid rocks may be distinguished within the district of which the limits have been given above, which, however, are connected with and pass into each other by intermediate gradations.

On the eastern and southern border of the granite country, the rock is not unfrequently of a tawny yellow color, and in character approaches the variety commonly known as eurite. Most of the higher ridges at the sources of the Musquash River are to a greater or less extent made up of this variety of granite. Generally the rock is porphyritic with crystals of flesh-red or tawny feldspar, sometimes one and a half inches across; in some places it is cellular, but generally compact, hard, and highly feldspathic, becoming occasionally, by the absence of mica, a granulite. The tawny color of the rock varies at times to red, producing a handsome material for architectural purposes.

West and north-west of the eurites, in the Nerepis country, are coarse granites varying in color from bright red to tawny yellow. Like the first named rock they are often porphyritic, but usually much more friable, crumbling readily when exposed to the weather. There are firm bands in it, however, which will make excellent building stone. These coarse granites occupy most of the country in the western part of the granite tract, where some portions are of a beautifully bright red color. Generally they contain but little mica, and quartz is more abundant than in the eurites; the feldspars too are often of two colors, white (albite or oligoclase), and red or flesh-colored (orthoclase.) Some granites on the West Musquash are full of crystals of reddish feldspar enclosed in the white species. In the same district too, the granites hold occasional pebbles of gneiss and quartz, and have a laminated appearance, presenting, in weathered ledges, a striking resemblance to coarse red sandstones.

At two points in the granite country, viz., on the Nerepis River and New River, syenites of tawny yellow color are associated with the great mass of porphyritic granites, but were not seen in the intervening district of the West Musquash. Rounded fragments of grey hornblendic gneiss are not unfrequent in these syenites. A quarry has been opened in this rock at Eagle Cliff in the Nerepis valley, and the material found to be of excellent quality for building purposes.

THE NEREPIS GRANITE REGION.

The general character and relations of the granites under consideration, as seen in the Nerepis region, have been given above. The extreme width of the crystalline belt at this point is about eight miles, its northern border being a little south of Gaspereau Lake in Douglas valley, and its southern coinciding nearly with the division-line between the Counties of Queen's and King's.

Between the lake above named and the summit of Douglas valley, along the northern slope of the granite range, the rock is rather coarse, containing much feldspar, and being of a loose and open structure. It is hence more liable to decomposition and decay than the more compact varieties farther south. Much of this granite also is cellular, having cavities lined with crystals of quartz, orthoclase and mica, and occasionally plates of a soft green mineral which is probably a hydrous iron-mica. At the gorge of Fall Brook, a small stream flowing into Gaspereau Lake, several varieties of this type of granite may be seen. The rock is here very strikingly laminated, dipping about N. 20° E. < 20°, of a deep brownish-red color, with cavities containing, in addition to the minerals above named, crystals of black tourmaline and purple fluor. It is followed a few rods to the north by beds of reddish crystalline felsite. **Douglas Valley.**

Near the summit of Douglas valley, and again at its southern entrance, the rocks which cross the track of the European and North American railway are coarse red granites of the ordinary type; but in the interval there is a large body of tawny eurite or fine grained feldspathic granite. Douglas Mountain is chiefly composed of this variety. The rock is of uniform texture, often variegated with crystals of feldspar, and breaks regularly and evenly under the hammer where it is free from seams and cracks.

Between the entrance of the Douglas valley and the high bluff known as the Eagle Cliff, no exposures of rock appear in or near the railway track, which runs over beds of quarternary gravel, sand and clay in the Nerepis valley. Bold hills, however, rise to a considerable elevation on the western side of this valley, and come out upon the river at Eagle Cliff. Here, two quarries have been opened in yellowish-grey syenite, and large quantities of the rock removed for building purposes along the line of the railway. It is well situated for transportation, splits readily into blocks of convenient size, and furnishes an excellent and durable building material. **Eagle Cliff.**

To the south of this tawny-grey syenite, lie about 1,500 feet in breadth of red syenite, in which the hornblende is not so conspicuously crystalline, and in which some indications of a laminated structure may be observed, although in a less degree than in the somewhat similar rock on the north side of the granite belt at Fall Brook. This rock merges into a body of felsites or granulites of dark yellow and reddish colors, which, in turn, appear to graduate into the lower beds of the overlying Upper Silurian series, they being im-

mediately followed by dark grey schistose silicious rocks containing fossil shells, which intervene between them and similar felsites a short distance farther south. These latter are, in turn, succeeded by other slates, also fossiliferous, the whole dipping regularly southward at angles of from 60° to 70°. Some of these felsites are not unlike those above noted north of the granite at Fall Brook.

From the Nerepis region to the westward, the country occupied by the granite belt is, to a great extent, covered with woods and difficult of access. It has however been penetrated at a number of points, sufficient to determine its general outlines and character.

About two miles west of the Nerepis River, the slates of the Upper Silurian series are found to terminate against a granite plateau, which extends thence in a southerly direction nearly to Loch Alva on the East Musquash, cutting off the basin of schistose rocks at the Nerepis from another on the Lepreau and New River. The boundary between the slate and granite country in the first of these basins is roughly marked out by the depression through which the Brittain stream flows to its embouchure in this lake.

West Musquash River.

A few miles to the west, the West Musquash stream descends from the centre of the Nerepis Hills, between elevated ridges of granite, to Sherwood Lake, which lies in a depression of the granite country, with high hills on both sides. In the exploration of this stream, coarse red granite was found to be most abundant about its sources, although the finer variety was occasionally seen. Owing to the sparseness of settlers in this district, and the luxuriant forests covering an ample deposit of boulder-clay, but few exposures of the subjacent rocks were met with. Below Queen's Lake, this stream runs for some miles through a valley in the granite range as far as the falls above Sherwood Lake. At these falls there are low ledges of coarse friable red granite, which at first sight recall coarse red sandstones. The cliffs have an irregular water-worn aspect, such as results from the abrasion of beds of unequal hardness; and, on closer examination, this appearance seems to be due to the presence in greater or less abundance of closely set cleavage-planes, dividing the granite into thin sheets. It is not easy to explain why these should be more numerous in one band of granite than another. The planes of lamination in these granites dip northward (N. 30° W.) at an angle of 20°, and they have the same inclination one-eighth of a mile down the stream. At the falls they are divided by joints inclining N. 40° W. $<$ 60°, forming fissures which serve as passages for the water, which in places has worn channels similar to those often seen in sandstones. Near Sherwood Lake the granite has rounded masses of quartz, of six inches diameter or less, sparsely scattered through the rock.

In following the stream up through the valley above mentioned opening out into the basin of Queen's Lake, the laminated granites were seen at intervals, but less frequently than below; compact red granite and eurite pre-

vailing on the upper part. The same low inclination of the planes marked this laminated variety throughout, the dip being usually S. 30° E. $<$ 15°, but occasionally northeast or northwest. In type it resembles that of Fall Brook, on the north side of the granite belt.

At Sherwood Rips, below Sherwood Lake, and extending thence four or five miles up the Northwest Branch, is a coarse red variety with occasional blotches of finer grain. This rock is remarkable for the peculiar appearance of the feldspar crystals of which it is largely composed. These are red in the interior, but nearly white towards the outside. Boulders and pebbles of this rock may often be seen, mingled with other varieties, in the beaches along the sea-coast between Musquash and Chance Harbor. The country around Sherwood Lake and the northwest branch of the West Musquash abounds with boulders and blocks of granite, frequently twenty feet or more in diameter. They are so thickly strewn in the streams, as at times nearly to conceal their waters, when at summer-level, from view.

In an exploration of the granite country made along the course of New River, about nine miles westward of the Musquash district, the limit between the crystalline and the schistose rocks was found to be about eight miles northward of the point where this stream is crossed by the post-road to St. Andrew's and St. Stephen. In the interval, the land on either side of the stream is comparatively flat, mostly covered with sandy loam and with occasional ledges of diorite, gneiss and slates projecting above the general level of the surface. Beyond this flat and rolling country, granite hills extend to the source of the stream. The latter escapes from the rugged country where it has its source, through a pass in the outer range of hills, which is distinctly visible from the Bay of Fundy. This ridge consists of tawny syenite. It terminates in a high bold cliff called Porcupine Mountain, which overhangs the New River as Eagle Cliff, its congener, does the Nerepis. Behind this range the land for some distance is lower, forming a basin to which various branches of the main stream converge. About two miles above Porcupine Mountain, on the main stream, there are ledges of coarse tawny granite, enclosing masses of the same rock, but of finer texture. One mile further up the stream, the granite is porphyritic with large crystals of red feldspar. Three-quarters of a mile beyond this point, the ordinary coarse red granite is abundant. At Smith's Lake, which is at the source of one of the branches, this is replaced by fine grained tawny granite, containing little quartz, and porphyritic from bands of feldspar crystals. Much of the country towards the source of this stream is literally paved with granite blocks and boulders.

New River.

From Porcupine Mountain on New River, a chain of high hills extends southwesterly, and, with somewhat less elevation, comes out upon Lake Utopia, the northern half of which is surrounded by these granite eminences. On the eastern side of this lake the granite forms the shore from above Ludgate's mill nearly to Trout Brook, a distance of one and a half miles. At

the mills, and on the shore of Mill Lake, the rock is rather coarse, and contains much red feldspar, but a mile southwards, towards Trout Brook, is finer and of a grey tint. At this stream the granite is met by dark grey and red strata of the Mascarene series. On the western side of the lake these schistose rocks, some of which are filled with casts of brachiopodous shells, form the shore below the Thoroughfare, which connects Lake Utopia with the Magaguadavic River. Beyond this thoroughfare, to the north, the granite hills rise on either side of the last named stream, and have been observed for a distance of several miles; but how much of the wooded country beyond is underlaid by these red granites, and how much by other varieties, or by the darker colored syenitic gneiss of the Laurentian type, has not yet been determined.

Lake Utopia.

From the Magaguadavic River at the canal or Thoroughfare, the red granites extend to the westward, and lying to the north of the old post-road to St. Andrew's, sweep around by Lily Lake to the Roix road. At several points along this border of the granitic area, red crystalline felsites appear, and intervene between the granites and dark grey silicious and feldspathic rocks similar to those of Lake Utopia.

High hills of red granitoid rock rise on either side of the Roix road, near its junction with the post-road to St. Andrew's; but farther north, where the same road approaches the Digdequash River, the crystalline rocks more nearly resemble those which we have elsewhere described as Laurentian, than they do the red feldspathic granites of the Nerepis. In the valley of the river last named both formations are mostly concealed from view by the overlying schistose and dioritic beds which form the shores of this stream for a mile or more above the Digdequash mills. Farther west, however, towards Bocabec, the more ancient gneissic series rises prominently into view, and extends thence to the St. Croix River. The greater portion of these crystalline rocks are the dark grey syenitic and granitic gneisses described in connection with the Laurentian system; but at various points over the surface and around the border of the area which they occupy red feldspar granites have been observed, some of which very closely resemble the intrusive granites eastward of the Digdequash River, while in others this resemblance is less marked. Of the latter class are certain beds appearing along the flanks of the syenitic hills which skirt the northern shore of Passamaquoddy Bay. Thus, near Bocabec village, there are, between the diorites and sandstones of the Mascarene series and the dark grey gneiss to which reference has been made, beds of fine and coarse grained crystalline diorite, which are associated with and seem to pass into a syenite containing a pink or flesh-red feldspar, and through the latter into a fine grained pinkish granulite. Rocks of this character are often met with in the great Laurentian tract of western Charlotte County, but they are not at this point clearly distinguishable from the latter, and

Digdequash.

are separated from them by no well-defined line of demarcation. Farther west, similar rocks lie along the flanks of the high syenitic hills north of Bocabec Bay, but here the distinction is more marked; and there are also, besides a pinkish granulite, beds of red crystalline felsite, bearing much resemblance to those elsewhere seen in connection with the Nerepis granites. Along the Glenelg road, which crosses the ridges alluded to, these felsites, which are sometimes syenitic, appear as overlying patches upon the older rocks, while further north, along the southern side of Bonaparte Lake, they are associated with and partly covered by dark grey schistose petrosilex For some distance north of this lake the older gneisses prevail; but about the Upper Bocabec Lakes the red rocks again appear and consist of a pale red somewhat laminated and friable, very feldspathic granite, containing but little mica, and bearing much resemblance to some of the granites already described in connection with the intrusive rocks of the Nerepis region.

The wooded character of the district under consideration makes the determination of the limits of these red granites somewhat difficult, but it is probable that the area occupied by them is considerable, seeing that rocks presenting the same features have been observed at a number of points between the Glenelg road and the Frye road, and again on the line of the St. Andrew's and Quebec railway about the Upper Chamcook Lake and Goldsmith's Lake. Some of these red feldspathic granites, like those north of Bocabec, and about Goldsmith's Lake, appear to be connected with the dark grey Laurentian (?) gneiss, but those which appear at Chamcook Lake, and which have here a breadth of about half a mile, lying to the south of the main body of these gneissic strata, bear much resemblance to some of the intrusive granites of the hills at the sources of the Nerepis, Musquash, and New Rivers. We have elsewhere had occasion to draw attention to the close resemblance which these bear to the red variety of Laurentian gneiss when in a highly crystalline condition. They are indeed so nearly alike, that unless the red granite is in large mass, and its connection with the surrounding schistose strata is clear, it is impossible to distinguish it from the porphyritic crystalline variety of Laurentian rock, such as may be seen at Indiantown, near the city of St. John. The red rock of Chamcook Lake is highly feldspathic, of a brownish-red color, often weathering to a bright brick-red, and imperfectly syenitic. It shows, too, some indications of an eruptive origin, veins similar to those of the mass of the rock penetrating not only the adjoining dark grey syenitic, but also the overlying dark grey feldspathic and schistose beds. A similar relation is better seen a few miles to the westward, where the same rocks are exposed along the shore of the St. Croix River.

Chamcook Lakes.

St. Croix River

On the eastern side of this estuary, low bluffs of dark grey syenite form the shore from Waweig Inlet to a point about eight miles north of the town of St. Andrew's, and have been elsewhere described in our remarks on the Laurentian system. Here, nearly opposite the high bluff of

the Devil's Head, in Calais, these dark grey syenites gradually give place to red granitoid rocks presenting features similar to those of the Upper Chamcook Lake, and like them, bearing much resemblance to the intrusive rocks of the Nerepis Hills. They consist of an imperfect syenite, usually of a brownish-red color, but often weathering to a bright brick-red. Two kinds of feldspar are distinguishable, but red orthoclase greatly predominates, and at times forms nearly the whole mass of the rock. Quartz is present, but generally not abundant, while the hornblende is imperfectly crystalline, and scattered in dark earthy grains through the red feldspathic base. In texture the rock is rather coarse, and may at times be seen to contain masses or pebbles of grey granitoid rock and grey felsite. The mass is divided by numerous joints, of which the two most marked series run respectively north and east, dividing the rock into nearly cubical blocks. Some of these joints, especially towards the southern portion of the area, are occupied by dykes of dark grey diorite, while over the surfaces of others are often spread thin sheets of a bright green crystalline epidote. The rock is also divided by planes which are nearly flat, giving to the mass the appearance of a succession of beds dipping southwards at a low angle. At one point it is covered, for a few feet, partially concealed by soil, by a sort of conglomerate, composed of red syenitic pebbles in a paste of diorite. About sixty rods above Bradford's Cove, the red syenitic rock is overlaid by beds of feldspathic rock, which at the line of contact are red, and seem to graduate into the former, but a few feet on, become dark, fine grained and homogeneous. To these feldspathic beds succeed dioritic and amygdaloidal traps and hard grey altered sandstones, the latter in nearly horizontal beds, and with layers containing shells of *Modiolopsis* and *Lingula*.

On the western side of the St. Croix River the area covered by the red crystalline rocks is much more considerable than that upon the east; for while, on the latter, their breadth from where they are first seen to the point where they disappear beneath the stratified series above alluded to, does not exceed three-quarters of a mile, they here remain at the surface, and form the shore of the stream through the greater part of the town of Robbinston, a distance of nearly four miles; being covered only by small outliers of more recent rocks. In character the red rocks on this side of the St. Croix are much like those above Bradford's Cove, being a syenitic felsite, with imperfectly crystalline hornblende. With this, however, occur also, in the more northerly part of Robbinston, some beds of coarse red syenite, differing from the above in containing a large proportion of quartz in large round grains.

Robbinston.

The northern limit of the intrusive granites, between the Digdequash and the south branch of the Oromocto River, is not known, the intervening country being mostly low and flat, heavily covered by glacial drift, and in a state of wilderness; but from the abundance of granite debris in the soil

in the valley of the Magaguadavic, just south of the confluence of the Piskahegan with that river, it is evident that there is intrusive granite immediately below the mouth of the last named stream. From this point southward, along the valley of the Magaguadavic, the soil abounds with granite boulders as far down as the Upper Falls, where ledges of this rock cross the stream, and high granite hills are visible in every direction.

About the south branch of Oromocto Lake, in the settlement of Clarendon, the granites rise into ridges of moderate elevation, covered with boulder-clay. Between Sand Brook, eastward of this lake, and Douglas valley, the rock is mostly of the coarse red laminated variety, and is well exposed at Fall Brook, in the latter valley, just south of Gaspereau Lake. The granite is here very friable and cellular, the cavities frequently containing black tourmaline, sometimes in large crystals, with smaller quantities of a pale green mineral (probably a hydrous mica) and a little fluor spar. **Clarendon.**

From Gaspereau Lake, the northern limit of the granite in Douglas valley, the granite extends to the north side of Douglas Mountain, at the junction of the Douglas valley with the Nerepis valley. Both sides of the latter valley exhibit beds of Laurentian and Upper Silurian age, but southward of these the intrusive granites again form an elevated wedge-shaped tract, covered by forest-clad hills, which terminates in the Bald Mountain Ridge, on the boundary between King's and Queen's Counties. Bald Mountain, which, according to Dr. Gesner, is 1,120 feet high, is the most elevated point in this part of the Province, and is about two miles from the northern border of the tract occupied by the intrusive granite. The junction of these rocks with the quartzites, diorite and syenite of Laurentian aspect, may be seen at the outlet of the eastern Bald Mountain Lake, near Hardscrabble Settlement. **Bald Mountain.**

To the eastward of Hardscrabble Settlement, in the parishes of Hampstead and Greenwich, the country is still elevated, but very much broken, consisting of high hills of Huronian and Laurentian (?) rocks, separated by irregular depressions filled with Upper Silurian strata. In traversing this hilly region, along the roads which connect Oak Point on the Long Reach of the St. John River with different portions of Jerusalem Settlement, as well as through the wooded country immediately surrounding Long Lake, no indications of the presence of the intrusive granites were met with. Farther east, however, rocks bearing much resemblance to those of the Nerepis Hills may be seen along the northern side of the granites of Laurentian aspect, which reach the St. John River at the granite quarries in the parish of Hampstead. They are well exposed at the outlet of Fannen's Lake, one mile east of Long Lake, and about three miles from the quarries, where they consist of a moderately coarse granite composed of feldspar, varying from pink to flesh-red in color, quartz and black mica. The rock is divided by numerous joints having a uniform north and south course, into tabular **Hampstead.**

masses from two feet to twenty feet in thickness, dipping easterly at an angle of about 40°.

Contact of formations on Fannen's Brook.

On Fannen's Brook, which flows from Fannen's Lake, the contact of these granites with the overlying schistose rocks may be observed. About a quarter of a mile below the head of this stream, ledges of brownish-red granite are met with, holding fragments of fine grained rather dark grey and contorted gneiss, followed directly by ledges of the last named rock, with dark grey somewhat gneissoid feldspathic sandstone and reddish granular felsite. About two or three rods further down the stream the granite again appears in broad ledges, here with a bright red color, associated as before with dark grey gneissoid sandstone, through which the granite appears to have broken at numerous points, and which is intersected by veins of similar rock. The dip of the sandstone is N. $<$ 60°, varying to N. 10° E. $<$ 60°, this rock being followed by dark grey petrosilex, with a similar dip. These rocks, with contorted dark grey and grey argillites, occupy the remainder of the stream to within a mile of its mouth, where, from a bend in the stream, the granite is again approached, the last rock visible here being a pale red granular felsite, containing small fragments of dark grey gneiss. Not more than twenty feet of this rock are visible in the bed of the brook, it being immediately overlaid by dark grey shales. A similar pale red granular rock was seen in numerous fragments at the foot of the high hills just south of the Nerepis River, near Welsford Station, and *in situ* at Fall Brook in Douglas valley.

VARIOUS PRE-CARBONIFEROUS ROCKS.

The large area intervening between the granite hills of the Nerepis range and the southern border of the great coal-field is occupied by a series of schistose rocks of great thickness, the upper part of which resembles the Cordaite group of the Devonian series in St. John county, and has in connection with it beds which hold the remains of land-plants. The lower part contains near the base a succession of beds which lithologically resemble the lower half of the Mascarene series, and more remotely those sediments which, at Oak Bay and in the Nerepis Hills, contain fossil shells of Upper Silurian type. It also consists partly of a group of sandstones and

shaly beds, which may be compared with the Dadoxylon sandstone of the Devonian series in St. John County. We have not yet obtained the data which will enable us to assign these groups to their proper position in the geological scale, and have therefore been compelled to group them temporarily under the title of this section, premising, however, that divisions 1 and 2 very closely resemble corresponding groups in the Mascarene series. At two points within the area occupied by these lower rocks, namely, on Patterson's Brook and Perkins's Brook, both affluents of Back Creek, a branch of the South Oromocto River, very obscure remains of land-plants have been obtained from them.

In the region last named the lower dark grey rocks are well exposed, and present the following succession in ascending order :—

Division 1 :

(a) Hard flinty grey and dark grey feldspathic shales and quartzites. Synopsis.

(b) Well stratified highly feldspathic fine grained hard shales, a part of which are replete with alternating dark purplish-grey and greenish layers, and have seams of dark grey shale, minutely dotted with dull spots.

(c) Hard grey feldspathic shales with light grey seams and a minute network of white feldpathic lines.

Division 2 :

(a) Hard highly feldspathic dark grey or purplish-grey shales, with narrow and very regular color-bands of alternating grey and dark grey shades.

(b) Pale green and olive-grey, rusty-weathering, highly feldspathic schistose rock, with pale brown bands and shadings, and having irregularly lenticular layers of a lighter color.

(c) Dark grey, fine grained hard flinty shales, having elongated lenticular patches of a lighter color, and containing obscure plant-remains.

Division 3 :

(a) Grey, often micaceous and quartzose slates, alternating with fine grained smooth and shining dark grey or black fissile argillites.

(b) Hard grey rusty-weathering sandstones, alternating with grey micaceous slates and dark grey or black fissile argillites and carbonaceous shales.

(c) Grey white-weathering felsite or highly feldspathic sandstone, covered by black shales with obscure remains of plants.

The thickness of this series of grey and dark grey rocks has not been measured, but it may be roughly estimated from the width of the strata included between Three Bridge Brook and Perkins's Brook on the western side of the northern entrance to Douglas valley, where the measures from the base of Division 1 to the top of Division 3 expose a breadth of about three-quarters of a mile of nearly vertical beds.

We append the following details of the several districts in which these rocks have been observed.

CLARENDON.—Westward of Douglas valley, the lowest beds of this series observed were the hard grey shales veined with white feldspathic

bands and lines. They are visible on the slopes of the hills immediately above Three Bridge Brook and in the narrow valley through which that stream flows. For some distance from the post-road along the south side of the valley, the rocks are concealed by heavy beds of drift, but half a mile up, at a point where there is a driving-dam, the shales above named may be seen in close proximity to a hill of coarsely crystalline intrusive granite of the Nerepis range. The schistose rocks extend from one hundred yards to a furlong up the slope on the south side of the stream. The grey and dark grey flinty shales with elongated lenticular grey blotches are well exposed on the hills north of the valley, where they dip N. 20° W. < 80°. These sharply wedge-pointed lenticular grey patches or bands are equally characteristic of these beds as seen near White Birch Hill on Bear Brook, a branch of Sand Brook, on the Ogden road. Here the surfaces of the layers are covered with minute dark spots, aud the dip is the same as on Three Bridge Brook. The same set of beds outcrops on the northern end of the ridge running along the east side of South Oromocto Lake, and crosses the South Oromocto stream, forming low hills on its western side. Here they dip N. 10° E. < 70°.

South Oromocto.

The strata of Division 3, seen in Douglas valley, north of the petrosilicious rocks above described, are dark grey and black carbonaceous clay-slates, well laminated and speckled with black on the surfaces of the layers. Their dip is N. 40° W. < 80°. Upon these rest dark grey sandy and pyritous slate and grey quartzite, frequently pyritous and rusty-weathering, with the same dip. The highest quartzite beds (Division 3 *c*), which are feldspathic and white-weathering, become in part a fine conglomerate filled with small fragments of grey slate and felsite. The whole is surmounted by a mass of black carbonaceous shale visible along the banks of a small brook on the farm of Mr. Joseph Perkins. This shale abounds with comminuted vegetable matter, and contains badly preserved fragments of ferns and broad leaves. The same group of slates and sandstones is exposed in the valley of Bear Brook north of the petrosilicious strata on the slope of White Birch Hill, above noticed. The grey and black fissile slates and accompanying grey pyritous sandstones may be seen on the McLeod road near and at its junction with the Ogden road. They are speckled in the same manner as at Three-bridge Brook in Douglas valley; here, however, the spots take the form of a dark grey mineral in small but distinct crystals, with glistening cleavage-planes. The dip of the slates here is N. 20° W. < 80°. In the swale through which Bear Brook passes to its junction with Sand Brook, a branch of the South Oromocto stream, there are in connection with these slates beds of black graphitic and carbonaceous shales. A low ridge on the north side of the swale is composed of grey silicious felsite and dark grey quartzose sandstone, holding veins of epidote and specular iron, as well as common and arsenical pyrites. Here also there are beds of the black

speckled clay-slates. This group of slates and sandstones does not appear on the portage-road along the south branch of the Oromocto River, there being a swamp where it probably crosses that stream. Northwest of this swamp there are bosses of porphyritic granite similar to that of the Nerepis Range, on each side of Meadow Brook (or Coal Brook.)

South Enniskillen.

SOUTH INNISKILLEN.—The road through this settlement branches off to the westward about half-a-mile from the Government House on the main post-road to Fredericton. It crosses the two lower divisions of the rocks now under review at a very acute angle, the road having a westerly course. For some distance from the post-road it crosses fine grained grey and olive-grey argillites and rather hard slaty shales, similar in aspect to those of Upper Silurian age on the south side of the belt of Huronian rocks near Government House, and those in the vicinity of Blue Mountain. They are best seen on each side of a brook (Queen's Brook), which crosses the road in the eastern part of the settlement, where the dip is N $<$ 80°. Nearly a mile westward of this brook, there are exposures on the road-side of hard grey and dark olive-grey, feldspathic, well stratified rocks, with occasional spangles of pyrites, and dipping S. 10° E. $<$ 70°; and very hard fine grained feldspathic well laminated dark grey shales, speckled with black, holding narrow branching stems of plants, apparently sea-weeds. The dip of these beds is N. 5° W. $<$ 90°. After passing a clearing where there are two or three farms, the road is bordered for about a mile by woods and bushes. Here there are a number of outcropping ledges of the rocks of this series. The first seen were well laminated, highly feldspathic beds of Division 1 *b*, with alternating dark purplish and greenish layers spotted with spangles of pyrites. The latter color is due to a dark green chloritic mineral. (Dip N. 10° W. $<$ 90°.) In an abandoned clearing beyond, and apparently overlying these, are compact feldspathic beds with a fine network of white feldspathic lines. They are succeeded by ledges of rather dark purplish-grey, highly feldspathic hard shales, with very regular color-bands, alternately grey and dark grey; these dip N. 15° W. $<$ 90°. Less than a quarter of a mile west from this clearing, along the road, there are overlying beds, exposed in hard rounded ledges. These are olive-grey rusty-weathering schistose rocks. In the lower beds of the mass the lines of sedimentation are not obvious, but may be distinguished on freshly broken surfaces; while the color-bands, which are interrupted, are irregularly lenticular in form. The upper part of the mass is more schistose, and is also seamed with grey elongated, lenticular, feldspathic blotches. Still higher beds near these have pale brown bands and shadings, and are streaked and spotted with red quartz veins. For half-a-mile from this point the road runs over a level wooded tract of clay land without rock exposures. Opposite Stanton's house, at the end of this road there are outcropping ledges of dark grey flinty shales, with remains of land-plants very badly preserved. They appear to be of the genera *Lepido-* Fossils.

dendron and *Calamites*, with fragments of ferns. This rock is also marked by the elongated lenticular grey color-bands seen in the schistose strata above described. The beds dip N. 10° W. < 90°. From this settlement a wood road leads down along Patterson Brook to Gaspereau station on the Western Extension railway. Silicious strata of this series appear along the banks of the stream as the station is approached. They are succeeded by dark grey argillites seamed with quartz, the quartz veins running nearly parallel to the strike of the beds, which dip N. 35°. W. < 90°. With these are coarsely schistose grey sandstones, dipping N. 50° W. < 70°.

Hampstead.

HAMPSTEAD.—To the eastward of the Enniskillen Settlement, and northward of the belt of Huronian and Upper Silurian rocks which extends through the parish of Petersville to Blue Mountain in the parish of Hampstead, the lower grey and dark grey beds now under review do not appear, being probably concealed by deposits of Lower Carboniferous age met with in the southern part of Jerusalem Settlement. To the eastward of the latter, however, beds of this character may be seen on the northern side of the granite hills which come out on the St. John River below the village of Hampstead. Reference has already been made in earlier pages to the contact of these granites, which resemble those of the Nerepis Hills, with the overlying schistose beds on a large brook (Fannen's Brook), which flows from Fannen's Lake. The rocks through which the crystalline mass would appear to have been protruded near the last named sheet of water, are dark grey, highly feldspathic rocks, which, near the contact, are somewhat gneissoid and contorted, but in the higher beds are more regularly stratified, becoming a fine grained feldspathic sandstone, with a dip varying from N. to N. 10° E. < 60°. These rocks bear some resemblance to a series of dark colored quartzites, described in connection with the Upper Silurian series as occurring along the southern side of the Nerepis valley, as well as to the lower portion of the Upper Silurian rocks in the Oak Bay district, and less markedly to a series of quartzose rocks to be presently noticed in the Piskahegan Settlement, in the northern part of Charlotte County. Overlying the beds in question, on Fannen's Brook, and having the same general dip, but with numerous minor corrugations, are dark grey clay-slates, some of which are rather unctuous looking, and filled with minute dull spots. These are exactly like some beds of Division 1 *b*. The higher portions of this series here exposed consist of dark grey and black shales, much contorted, which are probably of Division 3. Near the mouth of the brook, they are overlaid by the micaceous argillites of the higher group occurring in the region under consideration. (See page 197.)

Fannen's Brook.

PISKAHEGAN.—Between Clarendon in the South Oromocto country, and the Piskahegan Settlement in the parish of St. George, in Charlotte County a space of about ten miles intervenes, which is unsettled, and has not been visited by us. It is probably traversed by the grey rocks of this series, for they cover a considerable area in the Piskahegan Settlement. The most

Piskahegan.

southerly beds seen were those of Piskahegan Falls. These are dark grey evenly bedded feldspathic quartzites, portions of which are somewhat gneissoid. Minute sheaf-like groups of dark actinolite occupy seams in this rock. Some of the beds are so highly feldspathic as to come under the denomination of felsites. These have minute crystals of pyrites disseminated through the mass, giving it a rusty appearance on weathered surfaces. These quartzites are exposed upon the stream at short intervals for three-quarters of a mile above the falls, the dip in this distance changing from N. < 40° to N. 10° W. < 60°. A hill of quartzite and fine grained gneiss intervenes between these beds and other strata of this series in the Piskahegan Settlement on the east side of Hatch's Brook. About one quarter of a mile north from this brook, on the eastern side of the road, is another hill, of less elevation, along the sides of which are projecting ledges of rock. They are grey, and dark grey highly feldspathic hard shales, some of whose layers are of a purplish-grey color, and others are covered with small dark spots on the cleavage-surfaces. They pertain to Division 1 *b*, and dip N. 10° W. < 50°. At Niles's Brook, toward the upper end of the settlement, there are at the road-side ledges of olive-grey micaceous slates and fine grained dark grey argillites. These are similar to the beds of Division 3 *a*, and dip N. 10° W. < 70°. About one-quarter of a mile beyond this brook, a low ridge of red porphyritic felsite crosses the road; it contains grains of quartz and spots of epidote. Just beyond it is a ledge of grey silico-feldspathic rusty-weathering rock, holding disseminated pyrites, which resembles the strata of Division 2. The country to the north and west of this point consists of low uncleared land, heavily covered with glacial drift.

MAGAGUADAVIC RIVER.—Two miles above the confluence of the Piskahegan with the Magaguadavic, ledges of grey schistose sandstone and coarse micaceous slate are exposed along the right bank of the stream. They dip N. < 30°. About three miles further up the river, on the banks of a brook, are grey argillites and micaceous sandy shales. These have a dip N. 30° E. < 10°—30° and are similar to those of Division 3 *a*. At a second brook, half a mile further on, similar strata dip N. 35° E. < 30°. Here there are also dark grey feldspathic shales, with interrupted wedge-pointed bands. About half a mile above this point, ledges of light grey white-weathering feldspathic quartzite cross the stream, causing a low rapid, and having a northeasterly dip of 20° or 30°. These beds pertain to Division 3 *c*. For a mile or more beyond this point the river runs on the strike of the sandstone beds of Division 3, along their northward side. This portion of the series has here the aspect of dark grey flags. They may be seen at the southern end of Flume Ridge, and with the dark grey argillites upon which they rest, cross the Digdequash River, below Jones's Brook, in the Tryon Settlement. Thence they may be traced through the upper corner of St. David's parish across the northwest branch of the Digdequash. **Flume Ridge.**

DUMBARTON.—In this parish, much of which is still unsettled, and but partially cleared, we have been able to spend but little time. Its southern portion, near the granite hills, is chiefly occupied by a series of micaceous quartzites and sandstones, described in the section on the Laurentian system as occurring along the line of the St. Andrew's and Quebec railway, north of the Roix road. These quartzites, as stated in the section referred to, are probably the same with those which occur about Moore's Lake, in the parish of St. David, and which are there associated with a series of mica-schists holding staurolite and garnet, imperfect gneisses, etc. The relations of these rocks are not yet fully understood, but so far as known they appear to form parts of a single series. On the St. Andrew's railway the beds in question are followed on the north by feldspathic shales and felsites, succeeded, two miles north of Roix station, by purplish-black argillites. At the twentieth mile-post on the railway, there is a low anticlinal of black carbonaceous shales covered by dark grey argillites. Further up, at Dumbarton station, the Digdequash River passes through a depression between Pleasant Ridge and Dumbarton Ridge. Here occurs a band of dark grey flags, similar to those which cross the Magaguadavic River near the southern end of Flume Ridge. At many places near this station the surface of the ground is abundantly strewed with large tabular blocks of these rocks. Other beds of this series may be seen crossing the Digdequash River at the Rolling Dam; they are fine grained grey sandstones, dark grey argillites, and black carbonaceous shales. Strata of this character underlie a tract of flat land, extending eastwardly through from the Digdequash to the Magaguadavic, and in the opposite direction to the St. Stephen Branch railway, north of the village of Moore's Mills.

St. Andrew's and Quebec R.R.

Moore's Mills.

ST. STEPHEN AND ST. JAMES.—The rocks in the village just named are grey and dark grey imperfect gneisses and mica-schists, associated with dark grey shales and pale grey quartzites, and have been described in earlier pages in connection with the Laurentian system. To the northward of these, and beyond the railway which traverses the middle of the settlement, are hills composed for the most part of thin bedded sandstones and argillites, which vary in color from pale grey to dark grey, the sandstones forming layers from one inch to one foot in thickness, while both are more or less micaceous and rusty-weathering. Their dip is N. 30° W. < 40°. Beyond these beds, the belt of argillites alluded to in the last paragraph as crossing the Branch railway, extends through the low and swampy tract about Middle, Cranberry, and other lakes, at the head-waters of the Dennis stream. Some of these argillites are silicious, but more commonly they are rather soft, and sometimes carbonaceous or graphitic, while their surfaces, especially in the paler beds, are covered with minute corrugations. About two and a-half miles northwest of Moore's Mills, this series of dark grey rocks is followed by the pale silvery-grey micaceous argillites of the upper group to

be presently noticed. To the westward of Moore's Mills the same belt of dark grey argillites and associated strata may be seen on the roads leading north from St. Stephen to Basswood Ridge and Scotch Ridge, extending thence in the direction of the St. Croix River. So far as seen in this district, which is mostly low, flat, and heavily covered with gravel ridges and other superficial deposits, the series presents the same features as those described above in the vicinity of Moore's Mills, and on the St. Stephen Branch railway.

The dark grey strata of northern Charlotte and Queen's Counties, which have been described above, are bordered throughout their entire extent by a great belt of argillites and sandstones. These beds, so far as we have been able to ascertain, overlie them conformably; they are highly micaceous throughout, and are of a lighter color and more uniform in appearance than the dark grey sediments southward of them. They present the following variations in ascending order :—

Division 4.

a. Hard grey somewhat micaceous schistose sandstone, of no great thickness. Synopsis.

b. Dark grey or bluish-grey micaceous argillites weathering light grey; alternating frequently with thick beds of a coarser texture and greenish tint. The finer beds of this division are soft, and have silvery surfaces when weathered.

Division 5.

The beds last named graduate into other slates of coarser texture, all of which are greenish-grey in color and alternate frequently with thick beds of schistose micaceous sandstones, also of a pale green tint. The strata of this division usually a portion of carbonates of iron, lime and magnesia. The thickness of this Division is probably twice that of Division 4.

There is very little variation in the aspect of these rocks throughout the extensive district south of the coal-field over which they are spread. Owing to their vertical position and uniform character, it is difficult to form an estimate of their thickness. They have a width of four miles on the South Oromocto waters, and of nine near the western border of the Province, but at both these points the beds are probably repeated in sharp folds. There can be little doubt that they possess greater volume than the dark grey strata beneath. In color, hardness and general aspect, these sandstones and argillites closely resemble the Cordaite group of the Devonian series in St. John County, but they appear to be more voluminous, and to have a greater number of thick arenaceous beds. The following are some details of their character and distribution.

North-western Charlotte.—In the north-western part of Charlotte County this series occupies a wide area. On the St. Croix River, it extends from near the Little Falls downward to a point about two miles below the Grand Falls, On the road from St. Stephen to Woodstock it has a width

of about nine miles, namely from the Baillie Settlement to the county-line between Charlotte and York. Thus they comprise a large portion of the parish of St. James, and much of the northern part of St. Patrick. From the Scoodic and Canous Rivers on the west, they extend eastwardly with great regularity of position and uniformity of character, through Basswood Ridge, Lynnfield and Anderson Settlements, to the Digdequash River above Jones's Brook, near the junction of the St. Stephen Branch with the St. Andrew's and Quebec railway; thence to Flume Ridge on the Magaguadavic River, and onward to Brown Ridge on the east side of the Piskahegan River. Their dip changes from northwest in St. James', to north in Dumbarton parish. On the Magaguadavic the dip is to the north-northeast, and on the Piskahegan to the north-northwest. Throughout the series the dip is usually very high (80° or 90°), except in the synclinal bend on the Magaguadavic, where it is reduced to 50° or 60°. The presence of numerous thick sandstone beds in Division 5, as well as the firmness of the more schistose strata intervening between the arenacous bands, causes the higher portion of these pale grey beds to project above the general level of the country in broad rounded ridges. Many of them are sufficiently calcareous to effervesce with acids, and as they also contain carbonate of iron, they yield buff colored loams possessing considerable fertility. Hence we find that many of the most thriving settlements in southern New Brunswick are situated on this micaceous group. Such, besides those already mentioned, are Juvenile, Ballyshannon, North Inniskillen, and Petersville Settlement, in the South Oromocto country. The argillites of Division 4 are usually to be found in the depressions along the southern side of the ridges or swells of land underlaid by Division 5. In one of these hollows, near Cox's Brook, at the southern end of Flume Ridge, there are pale grey argillites, dipping S. 30° W. < 60°, and holding
Fossils. scattered remains of plants, of which seme are fragments of a species of *Lepidodendron*. At the brook-side there are numerous large blocks of the dark grey flags which are associated with the subjacent dark grey argillites; and about half a mile northward, ledges of dioritic sandy shale, slate-conglomerate, and black grey-speckled clay-slates appear, the former dipping N. 30° E. < 60°.

South Oromocto Country.—Nothing is known of this series in the unexplored space of ten miles intervening between the Piskahegan Settlement and the south branch of the Oromocto; but near the mouth of Sand Brook, a branch of this stream in Clarendon, there are ledges of olive and dark grey silvery-weathering argillites, which crop out along the bank of the brook, dipping N. 30° E. < 50°. Clay-slates of the same character may be observed projecting through the boulder-clay, on the McLeod road, for tv or three miles south-westward from Douglas Valley; they dip N. 30° W. < 80°. At Perkins's Brook in this valley, the lowest beds of this series may be seen to rest upon black shales at the summit of the dark grey sediments,

There are a number of short cuttings along the Western Extension railroad, exposing pale grey micaceous argillites and sandstones, in all of which the beds are nearly vertical, but the underlie of the cleavage-planes gradually decreases from 80° to 50°, in proceeding northward to the North Inniskillen road. The slates consequently break into wedge-shaped pieces, in which the scales of mica are arranged parallel to the lines of cleavage, causing the rock to split more readily in that direction. Two roads diverging from the post-road through Douglas valley enter the settlement on the above named road. On the more northern of these several exposures of sandstones of this series occur, the dip being N. < 25°. The soil also abounds with fragments of this rock. On the hill-side westward of Patterson's Brook, in the settlement itself, there are also a few outcropping ledges of this rock, dipping N. 5° W. < 90°. At the eastern end of the road, near its junction with the main post-road through Petersville Settlement, other beds of these micaceous sandstones appear.

HAMPSTEAD AND WICKHAM.—We have not traced the distribution of these micaceous rocks eastward of the above named point in Petersville, but have seen them in the Jerusalem Settlement, and observed them on the St. John River in Hampstead. They have here, between Little River and Fannen's Brook, (two streams flowing into the St. John at and below Long Island,) a breadth of about three miles, and the beds are nearly vertical. They consist, for the most part, of lustrous argillites of a pale green color, with some thin beds of diorite, but towards the granite they are somewhat darker, while in the opposite direction, on the hills in the rear of Hampstead village, fine greenish-grey white-weathering, lustrous slates alternate with duller grey feldspathic slates, and dark green chloritic slates, in beds from two to four feet in thickness. Their dip here is N. < 80°. About a mile above the mouth of Fannen's Brook the valley through which the brook flows, which has no great breadth, alone separates the argillites in question from the granitic mass, but higher up the stream there are beneath these argillites beds of grey and dark grey slates, a portion of which at least belong to the lower group of sediments considered in the earlier half of this section.

Hampstead

On the eastern side of the St. John River, argillites bearing much resemblance to those of Hampstead, and sometimes characterized by a pale green tint, may be seen at some points along the shore between Jones's Cove and the foot of Long Island, as well as to the eastward of the river in other portions of the parish of Wickham and in that of Springfield. They have not, however, been sufficiently studied to enable us to distinguish them in all cases from the argillites of the Upper Silurian and Huronian series, which occur in the same region, and in connection with which they have been referred to in earlier pages. A band of fine grey silvery-weathering argillites, which are probably of this series, extends through the northern part of the parish of Springfield. An isolated outcrop of similar clay-slates occurs in the middle

Wickham and Springfield.

of the great coal-field of New Brunswick, at Coal Creek and Grand Lake in Queen's County; here they are inclined at a high angle, and are surrounded by horizontal sandstones and shales of the Coal Measures.

PERRY SANDSTONE GROUP.

The rocks of the Mascarene series and older formations of Passamaquoddy Bay may be seen at many points to pass beneath a thick series of coarse conglomerates and sandstones, usually of a reddish color, and to a large extent made up of fragments derived from the metamorphic eminences on whose slopes they rest. In these evidences of unconformability to the more ancient rocks, as well as in their color and the entire absence of cleavage in the finer beds, this series of strata exhibits features of close resemblance to a mass of sediments which has been extensively spread over the eastern counties, and which at some points hold organic remains indicative of a Lower Carboniferous horizon. These however have not been found in the Passamaquoddy area, while at two points, viz.—at St Andrew's in New Brunswick and Perry in the state of Maine, the sandstones of the series have been found to contain plant-remains of Upper Devonian type. We cannot doubt, from a comparison of the two, that these formations are the same, though the beds which hold Devonian forms of vegetation at Perry may be lower in the series than those which have plants of the Lower Caaboniferous type in the Kennebecasis valley, and we therefore suppose that the strata in question constitute a group of beds lying at or near the base of the Lower Carboniferous series, and characterized by an Upper Devonian flora.

Relations to Lower Carboniferous.

The same remarks apply to the series of strata composing much of the peninsula terminating in Point Lepreau, which in color, position and other features bear a close resemblance to the rocks of St. Andrew's and Perry.

We may observe here that should the Devonian rocks of St. John County prove to be of the same age with those described under the designation of the Mascarene series in Charlotte County, it will follow that the plant-beds of Perry are separated from those of St. John by several thousand feet of Devonian strata.

·DETAILS OF THE PERRY SANDSTONE GROUP.

The largest area occupied by the rocks of the group about Passamaquoddy Bay, is that of St. Andrews, constituting the entire peninsula upon which the last named town is built, as well as the adjacent reefs and islands. The rocks in question may be observed in the northern part of the peninsula to rest unconformably upon the higher members of the Mascarene series partly filling inequalities of the latter, as upon the western and northern sides of Chamcook Mountain, and in small outliers about Chamcook Harbor. Their best exposures are upon the western side of the peninsula, where they present the following features. St Andrew's. Contact of formations.

At Johnstone's Cove, three and a-half miles above St. Andrew's, coarse red sandstones and conglomerates of this group rest upon nearly horizontal red sandy slates of the Mascarene series. Where first seen together, on the north side of the cove, the latter have a northeast dip of 20°, while the former dip southeasterly about 10°, but both are variable. The conglomerates hold pebbles of the underlying grey sandstones and slates, as well as of other more ancient rocks, such as red orthophyre or feldspar-porphyry, and dark grey quartzite. From Johnstone's Cove to Brandy Cove the same rocks, viz: grey conglomerates resting on bright red sandstones, form the shore in nearly flat beds, or with low undulations, the inclination being generally to the south, usually at angles of less than 10°, but sometimes rising to 20°. At the last named cove these sandstones are cut by a dyke of grey trap, the underlie of which appears to be to the north $< 80°$, but which is divided by joints dipping S. 20° E. $< 15°$. The masses between the joints, where weathered, peel off in concentric scales, disclosing a spherical interior, little columns of such spheres being thus developed, each of the diameter of about three inches. The sandstones near the dyke are changed from red to grey, and at the same time hardened and rendered more compact, while the shaly beds have been altered to a grey slate. There is no apparent change in the dip in consequence of this intrusion.

At Brandy Cove and Joe's Point, dark grey compact and amygdaloidal dolerites are conformably interstratified with the above named sediments. The latter are usually somewhat coarser in approaching beds of this character, and at the last named point are composed of pebbles from six to eight inches in diameter, consisting principally of red feldspar, with some quartz, black slate, etc. The traps which here cut through the Perry rocks do not differ in aspect from those seen farther north along the same side of the St. Croix River, which there intersect both the Nerepis granites and the Mascarene series.

From Joe's Point to St. Andrew's the dip of the beds is quite uniform

being a little east of south < 20°, but farther south towards the extremity of the peninsula, this becomes somewhat reduced. The beds too are finer in this direction, the coarse conglomerates and associated traps being absent; while on the surfaces of the sandstones are found impressions of plant-remains, as well as irregularly cylindrical markings which may be the fillings of worm-burrows.]

The organic remains of St. Andrew's are not so well preserved as those of Perry in Maine. The position and relations of the latter have already been indicated in connection with the Mascarene rocks of the district, page 158. Here, as at St. Andrew's, these rocks appear to have a great thickness, the plant-beds occupying a position somewhat below the middle of the series. These have yielded the following species, determined by Dr. Dawson, viz:—

Fossils from Perry sandstone.

Coniferous wood (Dadoxylon and Aporoxylon).
Stigmaria pusilla, *Dawson.*
Cyperites.
Anarthrocanna Pèrryana. *Dawson.*
Carpolithes spicatus. *Dawson.*
Lycopodites Richardsoni. *Dawson.*
Lycopodites comosus. *Dawson.*
Psilophyton, (probably three species).
Leptophleum rhombicum. *Dawson.*
Lepidodendron Gaspianum. *Dawson.*
epidostrobus Richardsoni. *Dawson.*
——— globosus. *Dawson.*
Cordaites (Pychnophyllum) flexuosus.
Cyclopteris Jacksoni. *Dawson.*
——— Rogersi. *Dawson.*
——— Brownii. *Dawson.*
Sphenopteris recurva. *Dawson.*
Sphenopteris Hitchcockiana. *Dawson.*
Trichomanites filicula. *Dawson.*
Filices, incertae sedis, two species.
Carpolithes lunatus. *Dawson.*

Descriptions and illustrations of the above named forms are to be found in the following publications of Dr. Dawson:—

On the Precarboniferous Flora of New Brunswick, Maine and eastern Canada. (Canadian Naturalist, May 1861).

On the Flora of the Devonian Period in northeastern America. (Quarterly Journal of the Geological Society, November 1862).

Farther observations on the Devonian Plants of Maine, Gaspé and New York. (Ibid, November, 1863). *

Besides the large areas of St. Andrew's and Perry, rocks of the group under consideration appear at many other points about the shores and on the islands of Passamaquoddy Bay, and indicate their former wide extension. Of these the most interesting are those constituting a portion of Point Midjic and the opposite shore at the mouth of the Magaguadavic River. At the locality first named the rock is chiefly sandstone with some conglomerate, and both of a bright red color, but at several points and half submerged ledges seen along the shore eastward of this, the rock is a coarse dark conglomerate, abounding with boulders and large angular fragments of the adjoining Mascarene rocks. Just around Cape Midjic to the eastward, a steep wall of slates and trap forms a part of the sea-cliff. On the one side the sandstones of Cape Midjic abut against it, and small patches of this bright red rock may still be seen clinging to the cliff of older rocks at the height of from thirty to fifty feet from the beach; on the other side, the wall is terminated by a lower point of rock of the same age as the sandstones of Cape Midjic, but of a darker color, filled with angular blocks of diorite and conglomerate from five to fifteen feet in diameter. Point Midjic.

Rocks similar to the above, but somewhat coarser and darker, appear at the mouth of the Digdequash River. Other small outliers are seen on the shore between Chamcook Harbor and Bocabec Bay, and upon the following islands, viz.—Minister's, Hospital, St. Andrew's and Doyle's (north side).

The representatives of the Perry rocks at Point Lepreau occupy, with reference to the older series, a position analogous to those of Passamaquoddy Bay. As already described in preceding pages, the greater portion of the district lying to the west of Musquash Harbor and thence to Mace's Bay is occupied by strata probably of Huronian age, but in passing from these towards the promontory in question, a series of comparitively coarse sediments is met with, apparently unconformable to those just mentioned, as well as very dissimilar in the features which they present. Point Lepreau.

Where these rocks are first met at Dipper Harbor, they consist of coarse dark brown conglomerates, holding large pebbles of hard slate, granite and quartz, dipping northerly at an angle of 40°. These conglomerates extend quite across the peninsula, being visible at several points between Dipper Harbor and Mace's Bay, as well as along the eastern shore of the latter to within a short distance of Lepreau Basin. They hold at one point a consider-

* Since the above was written a Report prepared for the Geological Survey by Dr. Dawson has appeared *On the Fossil plants of the Devonian and Upper Silurian of Canada, etc.*; 92 pages 8vo. with numerous wood-cuts and twenty plates. The plants of St. John are there referred to the Middle Devonian, and those of Perry to the Upper Devonian. Publishers, Dawson Bros, Montreal; Sampson, Low, Son and Marston London; 1871,

able deposit of very white limestone, having a concretionary structure. In going southwards, towards Point Lepreau, and at the distance of about one mile from the latter, the conglomerates alluded to are succeeded by shaly sandstones dipping N.W. < 20°, and again, at the distance of one-quarter of a mile, by greyish red sandstones, with a dip N. 10° W. < 30°. These latter, capped on the west by pale red sandstone, and having a uniform northwesterly dip, extend to the Point. They here exhibit numerous round impressions some of which may be worm-burrows, while others resemble footprints.

The discordances in dip, some of which are above given, render the relations between the dark brown and the red rocks somewhat obscure, and at first suggest the idea that the latter may be Triassic. Their resemblance, however, to the beds of St. Andrew's and Perry, both in color, texture, and in the impressions, to which reference has been made, leaves little doubt that they are members of the same formation. There would seem to be a synclinal structure between Dipper Harbor and Mace's Bay, the conglomerates forming the bottom of the basin, while its upper members are represented by the bright red sandstones.

Small patches of conglomerates of this series also occur at Lepreau Harbor, where they rest unconformably upon strata of the Laurentian and of the Kingston group. On the northern side of the same harbor, and about half a mile below the village of Lepreau, grey conglomerates and sandstones, probably of this age, are exposed, together with grey sandy shales, dipping N. 20° W. < 50°. The latter contain numerous but ill-preserved remains of plants.

LOWER CARBONIFEROUS SERIES.

The general position and character of the Lower Carboniferous in New Brunswick has already been indicated in the introductory section. If we except the conglomerates and sandstones of Perry, St. Andrew's and Lepreau, already described, (which occupy with relation to the older rocks a position similar to those of the formation in question), only small outliers of this extensive series occupy within the area to which this Report more particularly relates. We give here, however, a brief summary of its more important

features as seen in the eastern and central portions of the Province, the details being drawn, with one or two exceptions, from our previous publications.

The rocks of this formation occupy in the region alluded to a very large area, comprising the greater part of the valleys between the older metamorphic ranges, and to the eastward covering the slopes and sometimes the summits of these latter. The great valleys of the Belleisle and Kennebecasis, comprising a large portion of King's County, and the continuation of the same great depression along the Petitcodiac River over much of Albert and Westmoreland Counties, are thus covered by them, as well as several detached areas along the coast, such as the neighborhood of Gardner's Creek, Quaco, and Salisbury Cove, and a long, narrow and broken belt extending around the margin of the great central coal-field through Queen's, York, Northumberland, and Gloucester Counties to the Bay Chaleur, connecting at the last named point with the Bonaventure formation of the Province of Quebec. Detached areas of these rocks, more or less considerable in extent, occur also covering the more ancient series at several points in the north and west of the Province, the most important being those of the Tobique River in Victoria, and the vicinity of Woodstock in Carleton County. Distribution.

Near Sussex, in the eastern portion of King's County, this formation consists of the following members, in descending order* :—

8. Reddish-brown arenaceous shales and red sandstone.
7. Upper conglomerate ; hard and massive beds.
6. Bright red sandstones and brownish-red shales and sandstones. [Brine-springs rise from these beds.] Succession in Sussex.
5. Grey sandstones, flags, and dark grey bituminous shales, with *Cyclopteris Acadica* and *Lepidodendron corrugatum.*
4. Conglomerate, limestone, gypsum and dark grey bituminous shales with *Terebratula sufflata*, etc. ; *Cyclopteris Acadica* and *Lepidodendron corrugatum.*
3. Lower conglomerate, hard and massive beds.
2. Break in section (probably shales.)
1. Basal conglomerate.

These beds vary considerably in following their line of outcrop. This is more especially true of the wide Carboniferous area to the eastward of the above section, where some of the upper members become reduced or changed in character. The lower members also in the same direction are variable, Nos. 1, 2 and 3 being sometimes wanting. This is the case near the Albert Mines, where dark grey bituminous shales, holding albertite, rest directly on the slopes of the older metamorphic ranges. These shales, besides the vegetable fossils above enumerated, are in some parts abundantly filled with Albert Co.

* George F. Matthew, Appendix to Dawson's Acadian Geology, second edition, page 687.

remains of ganoid fishes, referred to the genus *Palaeoniscus*, and probably identical with those so abundant in the cliffs of Horton Bluff, in Nova Scotia. With the Carboniferous rocks of the latter Province, those of New Brunswick connect through a series of sandstones and conglomerates of red and grey colors, which form the shores of Chignecto Bay, and which are probably the equivalents of those of the Joggins in Nova Scotia.

Coastal areas. In the coastal areas to which reference has been made, the hard massive conglomerates of Nos. 1 to 3 again come into view, and constitute some of the more remarkable headlands, but are associated with finer beds of red and grey colors, containing numerous vegetable fossils of the Lower Coal Measure type. There are here too, with these coarser beds, considerable masses of intrusive rocks, but these are not so abundant as in the central portions of the Province around the borders of the coal field.

Interior basins From the Lower Carboniferous rocks of the southern counties and the coast those of the interior differ mainly in the absence of the great ridges of conglomerate which form so striking a feature in the scenery of the former. They differ also in the more frequent occurrence of imperfectly crystalline rocks, which, in the form of dolerite and amygdaloid, may be seen forming beds of considerable thickness at many points around the border of the area occupied by the Coal Measures. These intrusive rocks are associated with feldspathic sediments of a quasi-igneous aspect, such as clay-stones, porphyries and tufas, as well as with the ordinary conglomerates and sandstones, the latter being usually of a bright red color. Beds of limestone, holding Lower Carboniferous shells and corals, occur at several points along the southern border of the basin, but have not been observed along that to the west or north, though the strata in the latter direction are generally calcareous or marly, and at times hold small masses of gypsum.

The outlier of this formation on the Tobique presents features nearly resembling those of King's and Albert Counties, consisting of red calcareous conglomerates and variegated sandstones, with red and green marls, limestone and gypsum. With that of Woodstock we are not acquainted.

Minerals. The economic minerals of this group are important, embracing, in addition to limestone and gypsum, brine springs, coal, bituminous shale, albertite, freestones, grindstones, and ores of manganese. Remarks on the distribution and character of these latter are deferred to the section on the useful minerals of the Province.

DETAILS OF THE LOWER CARBONIFEROUS SERIES.

Of the outliers of these rocks within our area the first is on the west side of Grand Bay on the St. John River, nearly opposite the embouchure of the Kennebecasis River, in King's County, being the western termination of the long

tongue of Lower Carboniferous rocks filling the valley of the last named stream. While the latter, however, are inclined at a moderate angle, those on the west side of the river are lifted up into a nearly vertical position, and dip to the northeast, being included between the strata of the Kingston group on the north, and the granitoid rocks of the Laurentian on the south. In their relations to the older series, as well as in their lithological features, they accord with what is seen of the same formation in the Milkish Passage, on the opposite side of St. John River. At the latter place, where the exposures are good, there is presented the following succession in descending order from northwest to southeast :—

a. Diorites, felsites and slates of the Kingston group of the Huronian series.

b. Grey grit and sandstones in repeated bands of about 50 feet in thickness, separated by depressions about 250 feet wide, in some of which red, grey, and olive colored shales, with a few ledges of grey sandstone, appear. Oblique lamination is sometimes strongly marked in the grits ; the shales contain occasional ripple-marked beds, and remains of land-plants are sparsely scattered over some layers. These grey beds are a part of the Lower Carboniferous series. **Succession at Milkish.**

c. Repeated alternations of dull red conglomerates and reddish-grey grit and sandstone, with dark red shales ; conglomerates being most abundant in the lower beds. These are the same in appearance as the rocks between Brandy Point and Law's Brook, on the opposite side of the river, and like the rocks of division *b*, belong to the Lower Carboniferous series.

d. Sandy shales and flags of a grey color, much contorted, and of which many layers abound with casts of worm-burrows or fucoids (*Palæophyci*) of several varieties. These are Lower Silurian strata beneath the primordial slates which appear farther east at Drury's Cove.

e. Granitoid and grey chloritic Laurentian gneiss, with beds or dykes of fine grained dark grey slaty diorite, nearly vertical.

The last named beds form the southern shore of Kennebecasis Island. On the other or southern side of Kennebecasis Bay, red sandstones and conglomerates of the Lower Carboniferous formation form the shore between Boar's Head and Sand Point, as well as a portion of the Narrows of the St. John River as far south as Bedam's Cove. The strata are but slightly inclined, exhibiting a series of low undulations.

Between Sand Point and Rothesay, this shore of the Kennebecasis, excepting a few beds of white sandstone and red shales to the east of Drury's Cove, presents only crystalline schistose rocks of the older formations, but beyond that point these are again concealed by Lower Carboniferous deposits, which also form portions of the northern shore of this stream, and the greater part of the islands which dot its surface. These deposits are principally remarkable for the coarseness of the conglomerates which here form so large a portion of their bulk, and which consist of imperfectly rounded fragments of granite or syenite, crystalline limestone, mica-schist, and soft brown sandstone, imbedded in a paste usually of dark red clay or sand, rarely in a grey calcareous mud. These pebbles, excepting that last **Kennebecasis conglomerates.**

named, have been derived from the rocks of the Laurentian system, and the older schists, limestones, etc., resting upon it. Similar conglomerates, etc., extend along the river to the eastward, as far as Apohaqui station near Sussex.

The rocks of Belleisle Bay, except that the conglomerates are somewhat less coarse, and destitute for the most part of the calcareous pebbles which are so common in the Kennebecasis conglomerates, do not differ essentially from these latter. They occupy much of the southern part of the parish of Springfield, and are well exposed along the roads which connect Kingston and Norton with the village of Belleisle. Upon each of these roads, limestones of this formation occur in considerable beds, those near the Fingerboard in Norton containing sulphurets of lead and copper. From Belleisle Corner, the Lower Carboniferous rocks extend both eastwardly and westwardly, consisting chiefly of the coarser beds, which, in the former direction, may be seen in a series of bluffs along the northern shore of Belleisle Bay to and beyond Jenkins's Cove, and in the latter constitute the eminence of Bull Moose Hill, as well as other high ridges to the eastward towards Callina Corner. Beyond Kierstead Mountain, in the same direction, our observations have not extended, but limestones and conglomerates of the formation are known at various points as far as Butternut Ridge in the parish of Studholm, connecting probably, in the neighborhood of the latter, with the similar rocks which skirt the southern border of the great central coal-field. The limestones in question are usually of a greyish-white color, and more or less bituminous. They hold, at Butternut Ridge and elsewhere, *Terebratula sufflata*, *Productus*, orthoceratites, fragments of crinoids, and other organic remains.

Belleisle.

Fossils.

Near Norton station the Lower Carboniferous rocks of the Belleisle valley blend with those of the parishes of Norton and Sussex, thence extending eastwardly to unite with the similar rocks of Albert and Westmoreland Counties. The arrangement of the beds as seen near Sussex has been indicated in the general remarks. The centre of the valley is occupied mostly the rocks of Divisions 4, 5, and 6, while further south, in the parish of Upham, the lower conglomerates come prominently into view, forming a series of bold ridges conforming to the course of the metamorphic hills. At many points along their southern border, which corresponds roughly with the valley of Hammond River, the calcareous beds may also be seen, and at Markhamville, near the sources of the last named stream, they hold valuable deposits of manganese.

Albert County

The Lower Carboniferous rocks of Albert and Westmoreland Counties, continuous with those of King's County, present, as a whole, the same features, but with some modifications in the relative thickness and arrangement of the beds. Along the Pollet River, near Elgin, in the first named county, the base of the series is represented by heavy beds of coarse conglomerate, resting upon the metamorphic hills, and largely made up of pebbles, from two to

thirty inches in diameter, derived from these latter. Above these conglomerates are hard grey sandstones and sandy shales, followed by calcareo-bituminous shales, holding ganoidal scales. Farther north are other grey sandstones and shales, with limestones, occupying most of the country between Elgin and Salisbury. These higher beds are probably the equivalents of the flags and shales of Nos. 4 (?) and 5, as seen about Norton and Sussex. The upper red sandstones and conglomerates appear to be wanting at this point, probably from denudation, but may appear farther north in the parish of Salisbury.

Through the eastern part of the parish of Elgin, the above named rocks appear at many points about the head-waters of the Coverdale River, resting upon the metamorphic hills, as well as filling neighboring valleys. The bituminous shales are here somewhat thicker than they are to the westward, and besides icthyic scales and teeth of the rhizodont type, hold fragments of *Lepidodendron elegans* and stipes of ferns. Farther east, in the parish of Hillsborough, these shales appear to form the lowest beds of the series, as will appear from the following section by Dr. Dawson, in the vicinity of the Albert Mines. The section is an ascending one (from 6 to 1). Fossils.

Section at Albert mines.

6. Calcareo-bituminous shales of the Albert mines.
5. Grey and dark-colored conglomerate.
4. Red sandstone and conglomerate.
3. Limestone and gypsum.
2. Reddish sandstones and shales.
1. Grey sandstone, often coarse and pebbly, with shales and conglomerate.

A similar succession was observed by Dr. Dawson, on the Memramcook River, in the parish of Westmoreland. The higher beds, which appear about Hopewell Ferry, are regarded by Dr. Dawson as probably equivalent to the great sandstone ledges of Seaman's quarry, in the Joggins of Nova Scotia. Similar beds form much of the low land between Shepody Bay and Salisbury Cove, but are here associated with beds of conglomerate, which, along the northern shore of Chignecto Bay, form a series of ridges terminating in Cape Enragé. Other conglomerates, also of a reddish color, form the upper half of Shepody Mountain. At their base, and occupying a position similar to those of Markhamville in Upham, are workable beds of manganese. Memramcook

In the detached coastal areas, which at several points appear along the northern shore of the Bay of Fundy, it is not always easy to distinguish between the rocks of the Lower Carboniferous formation and those of the Coal Measures. The following description of the more important of these areas is taken from our "Observations on the Geology of Southern New Brunswick."

"The Carboniferous rocks of Gardner's Creek and vicinity form a part of the largest of several deposits of this era scattered along the southeastern shore of the Province east of St. John; now isolated, but evidently marking the former existence of a large area of sediments in the depression filled by Gardner's Creek.

the waters of the Bay of Fundy, continuous with the coal-formation which bounds its northeastern end, and probably connected also with the Lower Carboniferous of the Kennebecasis valley by the depression of land at the mouth of the St. John River.

The strata of the district under consideration seem to lie in a series of undulations nearly parallel to those of the older series of metamorphic rocks, but having frequently a more northerly direction. These corrugations have been impressed upon the beds at some period between the close of the Carboniferous and the Triassic epoch, since, as will be shown in the sequel, sediments of the latter age are found resting upon the upturned edges of the Carboniferous beds.

Along the shore from Emerson's Creek to Quaco, cliffs of greater or less elevation afford excellent opportunities for studying the varied characters presented by these latter. The strata consist chiefly of sandstones and shales in frequently alternating beds varying from a few inches to twenty feet or more in thickness. The prevailing color is a chocolate-red, paler (and often giving place to grey,) in the sandstones, but frequently deepening to dark purplish-red in the shales. The sandstones often pass into grits, and more rarely into beds of a hard conglomerate, made up of pebbles derived from the indurated rocks of the metamorphic hills imbedded in a sandy matrix.

A few beds of dark grey shale occur and, with the finer sandstones, hold plants of several genera and species characteristic of the true Carboniferous formation, usually in an imperfect state of preservation, and by no means abundant. Specimens of these fossils were submitted for examination to Dr. Dawson, who remarks upon them as follows :—

Fossils.

" In looking over your Gardner's Creek plants, I find the following:—

" *Cordaites borassifolia*, and trunk of same.

" *Calamites Suckovii*.

" *C——— cannaeformis*.

" *Megaphyton* (species not determinable).

" *Sternbergia*.

" *Cardiocarpon* (several species).

" *Lepidophyllum*.

" *Neuropteris*, like *N. Loshii*, ?

" *Neuropteris*, like *N. auriculata*, ?

" In so far as they tell anything (and this is not very much), the specimens are Carboniferous rather than Devonian, and are more like the Millstone grit than any other part of the Carboniferous."

Westward of Wallace's Cove, massive beds of a hard conglomerate of grey and and brown colors, derived from the wreck of the Devonian and Huronian rocks northward, are brought up by an anticlinal fold in the formation, and constitute the principal mass of the bold promontory known as McKay's Head.

A similar deposit may be seen at Quaco and Rogers's Heads, resting on the flanks of ridges of intrusive trap. Near the light-house at Quaco it is associated with thick beds of limestone, and is covered by grey conglomerates and sandstones, holding *Calamites* and trunks of trees, with some thin beds of calcareous shale, the latter with *Cyprides* and *Naiadites*. Quaco.

As already intimated, the strata of this coal-basin are much folded and otherwise disturbed. Faults were observed at several places; and at Dewar's (Gardner's Creek) where the beds are curiously folded and bent, an admirable opportunity is afforded, both in the cliff and on the beach, for studying these phenomena. There seems to be an extensive overturned dip at this place, by which the higher members are inverted.

The remaining Carboniferous areas along the coast require but brief notice. At Martin's Head deposits of this age may be seen filling the space between the head and the high metamorphic series in the rear. They consist of soft grey sandstones, friable marls and shales of pale brown, grey and chocolate colors, and differ from the ordinary type of these rocks upon the coast in their remarkable softness and incoherence. They form a synclinal between the extremity of the head and the upland, reposing unconformably upon the rocks of the latter, with a southerly dip of 60°. They here hold beds and veins of gypsum, and are overlaid by several well defined marine terraces. Martin's Head.

A short distance to the eastward of the last named locality, red and purple conglomerates and grey slaty calciferous shales are exposed in nearly perpendicular beds, and form the eastern side of the harbor of Goose Creek. They probably represent the similar beds at McKay's Head and Quaco.

At Point Wolf, the hard conglomerates near the base of the series again appear, and rise into the bold ridge known as Owl's Head, attaining an elevation of not less than seven hundred feet. They are largely made up of pebbles of quartz, epidotic rock, jasper, slate, etc. derived from the older series, and are filled with slickenside surfaces. Resting upon them, and forming the northern side of the ridge, are fine grained grey sandstones and thin bedded conglomerates, the former holding remains of *Sternbergia, Calamites, Lepidodendron, Sigillariaon, Megaphyton*, etc., besides thin seams of coal and large trunks of undetermined trees. Point Wolf

As already intimated, the Carboniferous rocks of King's and Westmoreland Counties blend with those of the great central coal-basin about Buttternut Ridge, the eastern termination of the long spur of metamorphic rocks which separates the valley of Belleisle Bay and River from that of Washademoak Lake. Along the northern slope of this ridge, the Lower Carboniferous rocks are met with at many points, but their distribution, which is very irregular, is but imperfectly known. They consist for the most part of conglomerates, usually coarse and of a red or brownish-red color, and along their southern margin, near the county line, fill hollows and depressions among the older rocks. They are well exposed at Shaw's mill, in the southeastern part

Parish of Wickham.

of the parish of Wickham, and again to the westward of this point, along the road running northward from the valley of Spragg's Brook, having here an inclination N. 40° E. $<$ 20°. In the same parish, the limestones of the formation outcrop at several points, as near the house of Joseph Reichardt, one mile north of the county-line, where they may be seen to rest directly upon altered rocks, probably of Huronian age, and are associated with grey sandstones and sandy shales (dip N. 20° W. $<$ 20°), filled with poorly preserved stems of plants. They are quite soft, of mottled white and reddish colors, and are filled with brachiopodous shells. Similar limestones also outcrop still farther to the westward, at Rush Hill, and upon the opposite side of the St. John River in the parish of Hampstead. As seen near the river last named, the sediments associated with these limestones are peculiar in being of a highly feldspathic character, and of a quasi-igneous aspect. On its eastern bank, in the parish of Wickham, they consist of purplish-red feldspathic sandstones, and have a surface breadth of about two miles, extending from about half-a-mile above Golding's Corner to near the outlet of Washademoak Lake, with a low inclination to the northward, not generally exceeding 20°, but sometimes rising to 30°. On the western side of the same stream, in the parish of Hampstead, where their breadth is somewhat greater, they exhibit the following arrangement:—

Succession Hampstead.

1. Grey sandstones, in broad flat masses, having a slight northerly dip. These beds are seen on the hills south of Otnabog Lake, and are similar to those occurring elsewhere among the coal-measures.
2. Compact and vesicular dolerite, with coarse grey amygdaloid, holding calc-spar, quartz, and red heulandite.
3. Buff colored sandstones.
4. Soft ochreous bluish and yellowish shale, with splintery fractures.
5. Greyish and reddish semi-crystalline limestone. Some portions of this are soft and unaltered, being abundantly filled with shells (*Terebratula sufflata*, *Productus*, *Orthoceras*, *Conularia*, and more rarely joints of crinoids), while other portions are destitute of fossils, and are an imperfect marble. About thirty feet of these beds are exposed.
6. Beneath the last are thick beds of yellowish, reddish and purplish sandstone or sandy felsite, a rock in which pellucid grains of quartz are scattered through a paste which is highly feldspathic and often kaolinized. These are similar to much of the rock in Wickham.
7. They are followed by dark grey dolerite, in a bed about 20 feet in thickness, beyond which are sandstones similar to those of No. 6, but mostly concealed from view. These probably underlie the soil southwards to Little River, on the southern side of which they may be seen resting against nearly vertical greenish-grey micaceous slates. Much of the sandstone rock is here a nearly pure felsite, which, in hardness, compactness and uniformity of color, might readily be mistaken for some of the petrosilex rocks of the much more ancient Huronian series.

We have not observed the limestones of this formation westward of the

point above described, but sandstones and conglomerates, exhibiting the usual red or brownish-red tint of the series, and holding a similar relation to the metamorphic rocks and those of the coal-measures, appear through much of Jerusalem Settlement and westward in the parish of Petersville. Near Vail's Inn, on the Magaguadavic River, the belt of these rocks bends to the north and then to the northeast, extending through the Harvey Settlement to the St. John River, about ten miles above Fredericton. Beyond the last named stream they have been recognised about Stanley and Tay Creek in York County, as well as near Boiestown, and probably connect with the similar rocks on the Nipisiguit River near Bathurst.

THE CARBONIFEROUS SERIES.

The rocks of the Carboniferous system occupy in the central portions of the Province a district unequalled in extent by that of any other formation in New Brunswick. Covering a triangular basin of which the two principal sides are from one hundred to one hundred and sixty miles in length, they spread over a large portion of the counties of York, Queen's, Sunbury, Kent, and Northumberland. From near the Oromocto Lake, in the first mentioned county, as the apex of the triangle, the basin in question widens rapidly to the eastward, embracing along the line of the St. John River the entire district between Fredericton and the Washademoak Lake in Queen's County. Farther to the east, the limits of the formation are less accurately known, but are believed to include the whole of a large district of which the most northerly point is in the neighborhood of Bathurst on the Bay of Chaleurs, and that to the south, near the village of Shediac, in the County of Westmoreland. Other areas, but of more limited extent, have been recognized near Gardner's Creek in St. John County, as well as along the coast in Albert and Westmoreland, where they connect with the rocks of the same great series in Nova Scotia. Limits of coal-basin.

The strata of the coal-measures are conglomerates, sandstones and shales like those of the Lower Carboniferous formation, but are mostly grey in color, and less coarse in texture. The coal-seams associated with these rocks are numerous but thin, none, so far as known, exceeding twenty-two inches in thickness. Indeed, the entire formation, notwithstanding its great superficial extent, is believed from various reasons to be comparatively thin. Among Characters.

others may be mentioned the very slight inclination which the beds exhibit in nearly all parts of the coal-field, and the fact that even near the centre of the basin these are penetrated by ridges of the older crystalline rocks, around which they seem to have been deposited.

Like the underlying Lower Carboniferous rocks, those of the coal-measures crumble readily, but from the abundance of arenaceous beds, and the absence of lime, produce a dry and sandy, or where the strata are more argillaceous, a tough and clayey soil, less fertile than those of the first named formation. The topographical features of the district over which the coal-measure rocks are spread, are also in some respects not favorable for its cultivation. Although it consists largely of moderately elevated lands, often intersected by lakes and rivers, it is for the most part level or gently undulating. From the clayey character of the soil and the imperfect drainage, lowswamps, bogs, and barrens often result, and a very considerable portion of the region in question remains in consequence in a state of wilderness.

The useful minerals of this series are coal, fire-clays, clay, iron-stone and sandstones suited for various purposes, remarks upon which will be given in another connection.

Of the extensive district to which the above observations apply, small portions only have been examined by us. We, therefore, defer a more detailed description until further investigations shall have been made. In the meantime we give here a list of the coal-plants collected from different portions of the basin, adding thereto a list of forms obtained from a locality recently made known in the western part of Sunbury County. The species in both lists have been determined by Dr. Dawson.

Fossil Plants of the Middle and Upper Coal Formations.

Fossil plants.

From various localities.

Dadoxylon materiarium, Dawson; Miramichi.

D.——— Acadianum, Dawson; Dorchester.

Calomodendron approximatum, Brongnt; Coal Creek, Grand Lake.

Antholites rhabdocarpi, Dawson; Coal Creek, Grand Lake.

Calamites Suckovii, Brongnt; Coal Creek, Grand Lake, Gardner's Creek.

C.——— Cistii, Brongnt; Coal Creek, Grand Lake, Bay of Chaleurs.

C.——— nodosus, Schlot. " " "

C.——— cannaeformis, Brongnt; Gardner's Creek.

Asterophyllites grandis, Sternberg; Coal Creek, Grand Lake, Bay of Chaleurs.

Annularia sphenophylloides, Zenker; Coal Creek, Grand Lake, Bay of Chaleurs.

Sphenophyllum emarginatum, Brongnt; Coal Creek, Grand Lake, Bay of Chaleurs.

S.———— saxifragifolium, Sternberg; Bay of Chaleurs.

Cyclopteris (Nephropteris) obliqua, Brongnt; Coal Creek, Grand Lake.

C.———— (Neuropteris) ingens, L. & H.

Neuropteris rarinervis, Bunbury; Coal Creek, Grand Lake, Bay of Chaleurs.

N.———— gigantea, Sternberg; Coal Creek, Grand Lake.

N.———— Loshii, Brongnt; Gardner's Creek (?), Bay of Chaleurs.

N.———— auriculata, Brongnt; Gardner's Creek.

Odontopteris Schlotheimii, Brongnt; Bay of Chaleurs.

Sphenopteris munda, Dawson; Coal Creek, Grand Lake.

S.———— latior, Dawson; Coal Creek, Grand Lake.

S.———— gracilis, Brongnt; Coal Creek, Grand Lake.

S.———— artemisifolia, Brongnt; Coal Creek, Grand Lake.

S.———— canadensis, Dawson; Bay of Chaleurs.

S.———— obtusiloba (?) Brongnt; Bay of Chaleurs.

Alethopteris lonchitica, Sternberg; Coal Creek, Grand Lake.

A.———— nervosa, Brongnt; Bay of Chaleurs.

A.———— muricata, Brongnt; Bathurst.

A.———— pteroides, Brongnt; Bathurst.

A.———— Serlii, Brongnt; Bay of Chaleurs.

A.———— grandis, Dawson; Bay of Chaleurs.

Beinertia Geoppert, Dawson; Coal Creek, Grand Lake, Bay of Chaleurs.

Palaeopteris Hartii, Dawson; Coal Creek, Grand Lake.

Lepidodendron Pictoense, Dawson; Coal Creek, Newcastle River, Grand Lake.

Lepidostrobus squamosus, Dawson; Coal Creek, Newcastle River, Grand Lake.

Cordaites borassifolia, Corda; Coal Creek, Newcastle River, Grand Lake.

C.———— simplex, Dawson; Coal Creek, Grand Lake, Bay of Chaleurs.

Cardiocarpum bisectatum, Dawson; Coal Creek, Newcastle River, Grand Lake.

Noeggerathia dispar, Dawson; Bay of Chaleurs.

Halonia sp (?) Dawson; Coal Creek.

In addition to the above, *Sigillaria* of several species, together with *Stigmaria* and silicified trunks of undetermined trees, occur at Grand Lake and elsewhere within the Carboniferous basin.

From Three-tree Creek, County of Sunbury.

Neuroptis flexuosa, Sternberg. Some of the specimens might be referred to *N. Loshii*, Brongnt, but are, I believe, smaller forms of the above.

Neuropteris cordata, Brongnt; one of the forms named *N. hirsuta* by Lesquereux.

Pecopteris arborescens, Brongnt.

Pecopteris oreopteroides, Sternberg; or an allied species.

Pecopteris abbreviata, Brongnt.

Pecopteris allied to *P. hirta*.

Sphenopteris latior, Dawson.

Odontopteris squamosa, Lesquereux. Similar to Lesquereux's species except in wanting the scaly surface. This fern has not before been found in British America.

Cyclopteris fimbriata, Lesquereux.

Lepidodendron Pictoense, Dawson.

Lepidostrobus.

Cordaites borassifolia, Unger.

Annularia equisetiformis, L. & H.

Calamites Cistii, Brongnt.

Rhabdocarpus ? new.

Dr. Dawson remarks that the above plants are of the Middle Coal formation, and similar to those from Grand Lake, though there are several species not as yet found at that place. The absence of any specimens of Sigillaria or Stigmaria in this collection is probably accidental.

NEW RED SANDSTONE OR TRIAS.

The deposits referred to the Triassic or New Red Sandstone formation, so far as known, are confined to the vicinity of the Bay of Fundy, embracing certain areas of limited extent along the coast of St. John and Albert Counties, and a portion of the island of Grand Manan. The following description of the former is taken from our "Observations on the Geology of Southern New Brunswick."

History. The occurence in this Province of deposits of later date than the Carboniferous era has long been a disputed question; for while Dr. Gesner asserted in his Reports that the sandstones of St. Andrew's (shewn to be Devonian,) those of the Kennebecasis and Petitcodiac Rivers, and certain deposits west of Gardner's Creek, (which are Lower Carboniferous,) and the higher strata

of Grand Lake, (probably Carboniferous)—were all New Red Sandstone; Dr. Robb, on the contrary, was of the opinion that no rocks of this age occur on the north side of the Bay of Fundy.

There are, however, three very limited areas on the bay-shore, in the counties of St. John and Albert, where deposits of this period do exist. The first is between Gardner's and Ten Mile Creek, one and a half miles long and half a mile wide. The second is at Quaco, where they may be seen in the depressions east, south and west of Quaco Head. They underlie the village, and probably extend along the shore to the eastern end of the settlement, where we observed them in contact with the older schistose rocks which form the shore-line thence to Little Salmon River. They also extend some distance beneath the waters of the bay, and may thus connect with the first mentioned area. A third outcrop is on the low shore of Salisbury Cove, east of Owl's Head. Here the action of the sea, in removing a covering of sand and gravel, has exposed two patches of red sandstone. **Distribution.**

The bulk of the secondary strata at the several localities above enumerated are red sandstones, but at Vaughan's Creek (Quaco) an upper group of beds appears, having an entirely different aspect. It is an incoherent conglomerate, of a grey color, consisting of sand and round boulders of quartzite, altered slate, etc., derived from the sediments of the metamorphic hills northward; being, as Gesner remarks, conformable to the red sandstones which constitute the lower part of the series, and perfectly stratified. **Features.**

These latter consist chiefly of soft earthy sandstones of a bright red color; but layers of conglomerate, holding quartz pebbles mixed with fragments of grey and brown sandstone, are common in those at Gardner's Creek. From the coarser beds, and from detritus on the beach at the last named place, were gathered the only organic remains which we observed, viz.—fragments of coniferous wood. As the majority of these were partly rounded, and imbedded with pebbles, they were probably derived from the ruins of the Carboniferous strata, in which, at the distance of a few miles, such fossils may now be seen. One however, bore no marks of transportation, and of it Dr. Dawson observes—"The fossil wood from the New Red Sandstone, though not well preserved, appears to be coniferous, and to have one row of discs on the cell-walls, in the manner of the Mesozoic pines of the genus *Peuce* or *Pinites.*" **Fossils.**

Many striking instances of oblique lamination were observed at the same locality, and indeed this irregular structure characterizes the formation.

At Quaco the lower beds are often concretionary or brecciated, while the more easterly deposit, at Salisbury Cove, although agreeing in other respects, has but a slight dip (to the E. N. E. $< 10^\circ$) and is of a pale color. The rocks of the lower or red member can be readily distinguished from the Carboniferous and Lower Carboniferous formations which they accompany (although frequently confounded with them by Dr. Gesner,) by the irregular thickness

and truncation of the layers, by the absence of fine shales and hard massive conglomerates, and in general by their bright red color.

The general course and inclination of the strata at Quaco and Gardner's Creek are remarkably constant, the dip being to the N. N. E., at angles varying from 25° to 45°, the highest beds at the latter place having the last named inclination. Here too, unless there are extensive downthrows on the south side of the numerous cleavage-planes by which the beds are intersected, the sandstones must attain a considerable thickness, probably eight hundred feet, seeing that they rise into cliffs one hundred feet or more in height, and extend half a mile inland. They are not contorted or folded at any of the places where we have examined them.

Disturbances.

From the features presented by the Lower Carboniferous and New Red Sandstone series at the two localities above named, we infer that a considerable period of time elapsed during which the numerous thick beds of sand, gravel, clay, and calcareous mud, now forming the limestones, conglomerates, sandstones and shales of the Lower Carboniferous and Carboniferous formations on the coast, were hardened into stone, the imbedded trees which they contain, silicified, and the whole series disturbed, pressed into sharp folds, injected with trap, and entirely removed in some places by denudation, before any sediments of the later or New Red series were formed. The latter, therefore, can scarcely be older than the Trias. But in their main features and in their relations to older formations, the red sandstones on the northwest side of the Bay of Fundy, agree with those which add so much to the fertility of Annapolis and Cornwallis valleys in Nova Scotia, and no doubt mark, in this direction, the limit of that tidal bay, traversed by strong and variable currents, in which Dr. Dawson supposes the latter to have been deposited.

Age of sandstones.

Loose beds of coarse shingle, which are found at the summit of the series, mark the influence of similar powerful currents and long continued wave-action on an exposed coast, at a later epoch.

Triassic rocks on Grand Manan.

The occurrence of deposits of the age of the New Red Sandstone in the island of Grand Manan was not definitely known before the summer of the past year, 1870. Although the most marked of these deposits, consisting of a wide belt of trappean rocks, was noticed by Dr. Gesner, by whom the first published account of the geology of the island was given, and the resemblance of their contained minerals, embracing a variety of zeolites, to those of the northern coast of Nova Scotia, was pointed out, no opinion of their age was expressed by that author. More recently, Professor A. E. Verrill, in a sketch of the geology of Grand Manan, already referred to in preceding pages, and published as an Appendix to the second edition of Dr. Dawson's Acadian Geology, alludes to the occurrence of stratified sandstones (not however seen by him), in connection with these trappean rocks and, from the appearance of the latter, offers the conjecture that they may be Devonian.

In the geological map accompanying the work last referred to they are represented as of Upper Silurian age.

That the deposits in question are more recent than either of the formations mentioned, and are equivalent to those of Triassic age so prominently displayed along the northern coast of Nova Scotia, is probable from the fact, that they do not resemble any portion of the Silurian, Devonian or other Pre-carboniferous sediments recognized in New Brunswick; while in the great extent and general aspect of the trappean rocks and their associated minerals, as well as in the color, incoherence and mode of occurrence of the sandstones connected with them, they forcibly recall the corresponding rocks of Triassic age, which appear elsewhere around the shores of the Bay of Fundy.

The area covered by these rocks in the island of Grand Manan is an extensive one, embracing a large proportion of its entire surface, having an extreme length of fifteen and an average width of about four miles; the older rocks, to which the above are unconformable, being confined to the north eastern end of the island, and a narrow belt extending thence along its southern side. By far the larger part of this tract is occupied by the trappean rocks, the soft red sandstones occurring only in very limited exposures, of which but one has been observed by us, though others are said to have been found in other parts of the island.

At the northeastern end of Grand Manan, the trappean rocks form the shore from Whale Cove to Long Eddy Point, a distance of about six miles, embracing what is known as the Northern Head. In the nearly perpendicular bluffs which here skirt the shore, with an elevation (according to Owen's Admiralty Charts, from which the other elevations given below have also been taken) of from two hundred and forty to three hundred feet, these rocks present the appearance of a low and broad synclinal basin, that portion near Whale Cove having a slight inclination northward (N. 40° W. $<$ 20°,) while at Eel Brook, just west of Northern Head, a somewhat greater dip is apparent in the opposite direction. This structure is rendered evident by differences in the composition and relative hardness of the beds, which are thus separated into layers visible at a considerable distance from the shore, varying from five to ten in number, and from ten to twenty feet in thickness; the harder beds being usually a hard compact augitic rock, of grey or dark grey sometimes greenish colors and uniform texture, with a slight tendency to a columnar structure; while the softer beds, which make up a considerable portion of the mass, are more variable, exhibiting shades of grey, green, red and purple tints, and are more or less vesicular. Much of the rock is a true amygdaloid, the cellules being filled with quartz, calc-spar, various zeolitic minerals, such as stilbite, heulandite, analcime, &c., with much dark green delessite, but seldom affording good specimens.

Whale Cove

At the Northern Head, between Eel Brook and Long Eddy Point, the stratification of the traps is less marked, the beds being more irregular and

Northern Head.

the columnar structure more pronounced. From the point last named to a small ravine about a mile to the west of Indian Beach, the shore, which here attains at some places an elevation of four hundred feet, again exhibits stratification, consisting of beds of amygdaloid, which are sometimes micaceous and chloritic, and of grey compact and columnar augite, in low undulations. At Dark Harbor, a transverse valley shut in by lofty hills (380 feet high), and forming almost the only break in this otherwise precipitous shore, a good section of this portion of the formation is afforded. The trap, which is here very hard, dark grey, compact and augitic, is finely columnar, the side of the ravine for several rods being almost wholly made up of prismatic blocks, sometimes standing nearly vertical, but more commonly inclined at low angles, or even horizontal, and varying in diameter from one inch to two feet or more. At the foot of one of the high bluffs which overlook the harbor from the east, a low terrace discloses, towards the sea, the only sandstones of this formation which we have observed. These are of a bright brick-red color, but slightly coherent and in some parts highly argillaceous. They dip about S. S. W., at an angle of 20°. Westward of Dark Harbor, the shore has not been examined by us, but Professor Verrill states that from this point to the southern end of the island he found the cliffs to consist of trap, estimated at from two hundred to four hundred feet in height.*

The southern border of the great trappean mass above described is approximately parallel to its northern, being marked in a series of low hills and bluffs, extending in the rear of the settlements, along the southern side of the island, from Whale Cove to Red Head. On the western side of Flagg's Cove, the traps approach within a few yards of the shore. Farther south they recede somewhat from the latter, but may be seen at many points along the rear-road connecting Flagg's Cove with Grand Harbor. Southwest of Grand Harbor they rise into hills of considerable altitude, including Mark's Hill (290 feet), and extend thence to Benson's Cove, just west of Red Head The extensive area lying to the northward of the above named localities, and including by far the greater part of the island, is a thickly wooded plateau, broken by some slight depressions parallel to its length, but mostly from two hundred to four hundred feet in elevation. The rocks, where they are exposed over this area, exhibit features similar to those already described.

Contact of formations.

Near Red Head, towards the southern end of the island, the contact of the traps with the older sediments is well exposed. These latter, which here consist of grey (red ochre-stained) argillaceous beds, with riband-like bands of color, are in parts much corrugated, but have a general northerly dip of 30° or 40°. At their junction with the intrusive mass these latter meet, and are overlaid by a coarse conglomerate, filled with pebbles of coarse grained dark green augitic trap, like that of Dark Harbor, which again underlies, and

* Two hundred to three hundred and fifty feet; (Admiralty Survey).

graduates into a coarse, strongly columnar trap of similar composition. From this point the eastern shore of Benson's (or Seal) Cove, is wholly composed of trappean rocks, in part columnar, but including also several beds of trap-conglomerate, holding fragments from two inches to three feet in diameter.

At Spragg's Cove, near the northern end of the island, the promontory upon which stands the Swallow-tail Light, is, near the middle, intersected by a dyke of trap about fifty feet in thickness, with a columnar structure, and much stained with iron, which does not differ from the great intrusive mass on the northern side of the island, and is probably of contemporaneous origin.

Statements indicating the occurrence of valuable beds of ore in connection with the intrusive rocks of Grand Manan, have been made at various times. None of these have been seen by us. Our attention, however, was more particularly directed to a study of the geological structure of the island, and we have examined but a small part of the entire area occupied by these rocks. We are informed by residents of the island that masses of native copper are sometimes but rarely met with among them. Like the similar traps of Nova Scotia, they sometimes contain disseminated grains of magnetic oxide of iron. A beach, composed in part of magnetic iron sand, in the vicinity of these rocks near Red Head, has probably been produced by their disintegration.

Prof. Edward J. Chapman, of University College, Toronto, who in 1870 visited the island of Grand Manan for the purpose of examining its copper deposits, published in the autumn of the same year a report in which he described the sandstones above noticed, and referred them, as we have done, to the New Red Sandstone period. His conclusion was however not known to us at the time of writing this report. Beds of sandstone in immediate proximity to the igneous rock are, according to him, so highly impregnated with copper-glance as to give promise of valuable mines. This deposit of copper ore resembles those found in rocks of similar age and under like conditions in Connecticut and New Jersey. Prof. Chapman

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ORES, MINERALS, AND ECONOMIC PRODUCTS.

In the preceding Report but little reference has been made to the minerals or other economic products which, to a greater or less extent, may be found in connection with the different groups therein described. This course has been adopted with the belief that such references might be better made collectively, and apart from the details of structure which have formed the bulk of the preceding pages. It may be proper to add that the geological structure of the region committed to us having been the principal object of our investigations, no special enquiries were instituted with reference to its mineral resources. We now present, in a condensed form, a summary of such facts bearing upon this subject as have come within our notice.

In the following notes, reference is made not only to metallic ores, materials of construction, etc., but to such mineral species as may be of economic or scientific interest, or which may be sufficiently abundant to constitute marked features in the series to which they belong.

The general arrangement is, in the main, similar to that employed in the "Geology of Canada."

METALLIC ORES.

The only ores of the metals at present known to occur in southern New Brunswick are those of iron, copper, manganese, antimony, lead, bismuth and zinc. The first three, and possibly the fourth, are in quantities which promise to be economically available.

Iron ores. IRON. In the form of magnetic oxide, iron is frequently met with disseminated in grains through the coarser syenitic and hornblendic rocks of the Laurentian system, but no well-defined ore-beds have been met with in it by us. The localities in which the mineral is most abundant are the vicinity of the Scotch Settlement in the parish of Springfield (where veins composed principally of this mineral, with some hornblende, were observed, having a thickness of about six inches, while crystals from half an inch in length are scattered throughout the mass of the rock); in the Nerepis Valley; in the parish of Petersville in King's County, and in the ridge of anortholite rocks near Dolin's Lake in St. John County. Veins of pure magnetic oxide

of iron, from two to three inches in thickness were observed in rocks of the Kingston group, two and-a-half miles westward of the village of Lepreau, in St. John County. In the eastern part of the same county, red hematite with specular iron ore occurs among the Huronian strata of the Quaco hills, and more abundantly in those of West Beach and Black River. The ore-bed at West Beach, twelve miles east of the city of St. John, is in the upper part of a large mass of coarse reddish-grey conglomerate, dipping to the south-east at an angle of about 30°, and is distant about a furlong from the shore. The main bed of ore is a dark reddish-brown hematite, but veins of quartz, with which the conglomerate is abundantly seamed, contain in addition scattered masses and veins of micaceous and specular iron. Two or three miles eastward of the above, in the direction of Black River, the iron ores are again visible, but are here associated with dioritic rocks and micaceous schists. Several beds are here exposed, of which one attains a thickness of twenty feet.

Besides the localities above alluded to, specular iron has also been met with in small veins in epidotic rocks of the Huronian series at Sheldon's Point and Pisarinco, along the coast to the westward of St. John, and in the interior, at Sand Brook on the South Oromocto, in connection with the argillites described on page 198. To the presence of this oxide, or that of the carbonate of iron, the great weight and rusty character of some of the dark grey and black slates of this series, and of the mica-schists in northern Charlotte County is to be in part attributed. Should any of these argillites prove to contain available quantities of this metal, the presence of carbonaceous matter, with which they are usually charged, would greatly facilitate their reduction.

Bog iron ores, in beds of greater or less extent, were met with at several points in connection with the grey argillites last alluded to, and with the black shales of the St. John group along the northern side of the granite hills of Queen's and Charlotte Counties.

Iron-pyrites.

Iron-pyrites, besides occurring in many vein-rocks in greater or less quantities, associated with the sulphurets of lead, zinc, and copper, is also found widely distributed through some of the sedimentary beds of the region under consideration. It is especially abundant in the strata of the St. John group, in Queen's County, and in the lower division of the argillites mentioned above. Mispickel or arsenical pyrites, though less frequent than the species last named, has been occasionally met with, as at the Waewig River near St. Stephen, and at Sand Brook on the South Oromocto. Pyrrhotine or magnetic pyrites also occurs, but is mostly confined to veins, in which it is associated with blende, galena, iron and copper pyrites. It is thus found at the copper mines of the Mascarene shore, and with the galena-bearing veins of Campo Bello.

Spathic iron

Spathic iron occurs in veins in the Upper Huronian rocks at Mr. W. Woods's, in the Nerepis valley. These veins vary in thickness from four

inches downwards, the associated green and purplish-red slates being also highly charged with the same mineral. The carbonate of iron is also diffused to a considerable extent through the Cordaite shales, and with the micaceous rocks of Northern Charlotte. The same mineral is met with on the island of Grand Manan and the associated islands, disseminated in crystals through micaceous strata of the Huronian series.

Manganese.

MANGANESE.—No ores of this metal have been met with in quantity by us in the district lying to the west of the St. John River, but they occur abundantly at several localities to the eastward, in the counties of St. John, King's and Albert. The most important of these deposits is that of Markhamville, near the sources of the Hammond River, in the parish of Upham, King's County. The ore at this locality is mostly a dark grey, partly crystalline pyrolusite, and is contained in beds of greyish-white fossiliferous limestone, red conglomerates, and shales of the Lower Carboniferous series. There is also much manganite at this locality. Notwithstanding the unfavorable position of the mine, operations have been in progress here for several years, and considerable quantities are annually removed and transported, by wagons and sleds, to the European and North American railway, at Sussex, a distance of about twelve miles. At the time of our visit (August, 1869), the mine at this place was giving employment to about thirty hands.

A second locality in which manganese ores occur, is Shepody Mountain, in Albert County. The ore-bearing rocks at this point are also of the Lower Carboniferous series; but while those of Upham just alluded to, repose upon strata of the Coldbrook group, these are underlaid by sediments of the Coastal type of the Huronian series. The mineral is, as a rule, less crystalline here than at Markhamville. Operations were carried on at this point for several years, but have been discontinued.

Near the light-house at Quaco Head, the Lower Carboniferous rocks also contain small beds of manganese, but the quantity of ore at this locality appears to be inconsiderable.

Copper ores.

COPPER.—Ores of this metal, in the various forms of the yellow sulphuret, copper-glance, erubescite, etc., are not of uncommon occurrence in the metamorphic districts of southern New Brunswick, and though these are for the most part in inconsiderable quantities, some of them promise to be of commercial value. The greater number belong to the Huronian rocks of the Coastal and the Kingston groups; a few are in rocks of the Mascarene series. To the two former belong most of the localities observed about Passamaquoddy Bay, as on Adam's Island, Simpson's Island, the La Lete shore, etc., as well as those occurring towards the head of the Bay of Fundy, in St. John and Albert Counties; to the latter belong those in the northern part of the Mascarene peninsula, in Charlotte County.

At most of the localities about Passamaquoddy Bay, the ore is erubescite or variegated ore, and occurs in connection with green and purple argillites

chloritic schists, and diorites; the ore-veins being usually developed near faults or in overturned anticlinal axes. A band of these cupriferous argillites and crystalline schists would seem to extend through the Mascarene peninsula, and thence through the smaller islands south of Deer Island. The largest deposits known in this region are those of Adam's Island, where operations have for some time been in progress. Specimens from this locality have been forwarded to the office of the Geological Survey. A second belt of copper-bearing rocks extends along the coast from Beaver Harbor eastward to Mace's Bay, being for the most part highly feldspathic and often granitoid rocks of the Coastal group of the Huronian series.

The copper ores of eastern St. John and Albert Counties, though probably in part of the same geological age as those last alluded to, are associated with rocks of a somewhat different aspect. These latter, which skirt the shore from Little Salmon River, in the parish of St. Martin's, St. John County, to and beyond Great Salmon River in Albert County, consist of grey chloritic grits and micaceous schists, often of talcoid aspect, associated with considerable quantities of diorite. The resemblance of these rocks to those of the eastern townships of Canada has been commented on by one of the authors in an Appendix to our Observations on the Geology of Southern New Brunswick. In St. John and Albert, as in Charlotte County, the more important ore is copper-glance, but copper-pyrites is also met with, and more rarely the red oxide or cuprite. These ores are usually in veins, which are partly calcareous and partly silicious, and generally more or less epidotic, but are sometimes disseminated in lumps or grains in layers of the slate, forming *fahlbands*. Attempts have at various times been made to mine the ores in question, but from a variety of causes, among which may be mentioned the forest-clad nature of the region and the difficulty of access, they have, with a single exception, been abandoned. Operations are still in progress near Point Wolf, but with what success we are not informed.

Deposits of native copper and also of sulphuretted copper ores are reported as occurring in connection with the traps of the New Red Sandstone era on the island of Grand Manan, but have not been seen by us. They are said to be of a promising character.

We may supplement these general remarks on the copper ores of Southern New Brunswick with the following table, which is intended to embrace a list of all the copper-bearing localities in the district alluded to, so far as these are known to us :—

Localities of Copper Ores.

Seely's Cove.—Quartz veins holding small quantities of copper-pyrites in a chlorito-feldspathic rock.

Charlotte County.

Seely's Head. (on the shore west of)—Copper-pyrites in small quantities in red syenite.

Seely's Creek.—Copper-pyrites in a quartz vein intersecting feldspathic rocks of the Coastal group.

Shore west of Crow Harbor Island.—Copper-pyrites and copper-glance in a quartz vein, about two feet wide, running through greenish-grey chlorito-feldspathic rocks. This is the most promising locality seen upon this shore.

Cove of Red Head.—Copper-pyrites and iron-pyrites disseminated through schistose talco-micaceous rocks of the Coastal group. No distinct lode was seen.

McLean's Mills on Locke's Brook near New River.—Copper-pyrites, in quartz lodes. The quantity is small. The rocks are similar to those of Red Head Cove.

Negro Harbor.—Copper-pyrites.

Beaver Harbor.—Copper-pyrites in quartz veins, and disseminated in schistose diorite of the Kingston group, (div. 3); also with galena, in a quartz lode (three and a half feet wide) in chlorito-feldspathic rocks of the Coastal group.

Clark's Point, Mascarene shore.—Native copper and grey copper ore in strings and pockets in trap associated with red argillites of the Mascarene series.

Wheal Louisiana Mine, La Tete.—Copper-pyrites with some erubescite, iron-pyrites and pyrrhotine, in diorite and hard clay-slate of the Kingston group (div. 2).

Woodward's Mine, Mascarene.—Copper-pyrites in diorite of the Kingston group.

Hardwood Island.—Purple copper or erubescite, in strings and bunches in greenish chloritic schists.

Adam's Island.—Erubescite in veins of calc-spar and quartz, associated with grey amygdaloidal and compact diorites, green and red argillites and conglomerates of the Coastal group. Operations are in progress here.

Simpson's Island.—Copper-glance and malachite, associated with trap rocks and slates, which are probably a continuation of those of Adam's Island.

Campo Bello Island.—Near the village of Welshpool, copper-pyrites, associated with iron-pyrites, galena and blende, in hornblendic and slaty rocks of the Kingston group. Opened but abandoned.

Grand Manan.—Native copper and copper-glance in connection with trappean rocks of the New Red Sandstone series.

St. John County.

Black River Settlement.—Copper-pyrites and malachite, in hard clay-slate containing remains of plants; also copper-glance in limestone.

Little Salmon River (near its mouth).—Copper-pyrites, in small quantity, with much iron-pyrites, in slates of the Coastal group.

Near Martin's Head.—Erubescite, in rocks of the Coastal group.

Vernon Mine (near Goose Creek).—Erubescite, copper-pyrites, malachite and cuprite, (red oxyd) in veins and *fahlbands* traversing dioritic rocks, associated with purple and grey micaceous slates, conglomerates and grits, which are either of the Coldbrook or the Coastal group. Operations were carried on at this point for some time, but have been abandoned.

Albert County

Point Wolf.—Between this point and Great Salmon River copper ores, consisting of erubescite and copper-pyrites, have been observed at a number of points. They are in a continuation of the same metalliferous belt as those of Martin's Head and the Vernon mine. Operations are still in progress in this vicinity.

Westmoreland County.

Salmon River.—Three miles north of the settlement at the mouth of this stream, variegated copper ore and copper-pyrites occur in small quantities in dark grey slaty grits.

Blackwood Block.—Malachite in hard grey slate.

Beech Hill, parish of Dorchester.—Copper-glance in veins of quartz with fluor.

King's County

Quispamsis.—Copper-pyrites with galena and blende in grey chloritic Laurentian gneiss.

Norton.—On the north side of Dickie Mountain, copper-glance is found encrusting grey quartzite of the Kingston group, and overlaid by Lower Carboniferous limestone with galena.

Springfield.—In the Scotch Settlement north of Bull Moose Hill, copper-pyrites and copper glance have been observed at several points on the farms of Michael Gallagher and ——— Stewart in pale grey argillites; also farther east on the southern slope of Kierstead Mountain.

London Settlement, parish of Kars.—Copper-pyrites in rusty-weathering feldspathic sandstones.

McKenzie's or Nerepis Station, parish of Westfield.—Copper-pyrites, with galena and iron pyrites in purple slates of the Coastal group.

Antimony.

ANTIMONY.—Small quantities of stibnite or grey sulphuret of antimony have been found in connection with dioritic rocks, which are either intrusive or of Laurentian age, near Sunnyside Lake, in the Scotch settlement, parish of Springfield, King's County. A small portion only of the vein has been disclosed by the removal of the soil, and little is known of its extent or value. Another and apparently a more important deposit of similar composition has for some years been known, and has been partly explored in the parish of Prince William, York County, but is outside of the limits to which this report more immediately relates. The rocks of this latter locality are hard grey sandstones and argillites of unknown age.

Lead.

LEAD.—Galena or sulphuret of lead occurs at a number of points in the southern counties, in connection with rocks of very different ages, but no-

where in quantities sufficiently great to be of economic importance. The localites at present known are the following :—

Hammond River, near Wanamake's Inn. parish of Upham, King's County. Galena here occurs with small quantities of copper-pyrites in quartz veins in dioritic and petrosilicious rocks of the Coldbrook group.

Norton, north side of Dickie mountain, King's County. Galena here occurs in Lower Carboniferous limestone.

Quispamsis.—Galena with pyrites and blende in Laurentian gneiss.

Frye's (or Cailiff's) Island, Charlotte County. Galena with barytes, calc-spar, quartz and fluor-spar in veins intersecting crystalline limestone and dolomite.

Campo Bello Island.—Galena with iron and copper-pyrites, blende and pyrrhotine in veins of quartz and calc-spar, associated with hornblendic and dioritic rocks and slates of the Kingston group (div. 2).

Zinc. ZINC.—Blende or sulphuret of zinc, often accompanies the sulphurets of the other metals, and is thus found at Campo Bello and elsewhere, but in quantities too small to be of value.

Gold. GOLD.—We have not met with any evidence of the occurrence of this metal in the counties visited by us, Our observations, however, having been made chiefly to ascertain the structure of the region, it may be hoped that a more minute exploration with reference to this point, may result more favorably.

In connection with this subject it may be worthy of remark that the late Geological Survey of the state of Maine, under Prof. C. H. Hitchcock, reported the occurrence of gold at two localities near the western frontier; the one in a mica-schist full of quartz veins and beds on the west side of the St. Croix River in Baileyville, the other about nine miles northwest of Calais bridge, in plumbaginous slate. The second of these localities, which is on the land of Mr. Bolton, M. P. for Charlotte County, has been visited by one of the authors in company with Dr. T. S. Hunt. Several large veins of milky white quartz, mingled with more or less of plumbaginous matter, were observed, the largest vein being contained in a bed of soft and earthy plumbaginous schist, while the prevailing rocks of the vicinity are imperfect fine-grained and ferruginous gneisses. No gold was visible to us in the vein, and specimens taken for analysis have also failed to show the presence of this metal. Both of these localities are in rocks which, so far as can be ascertained, are at the base of the Silurian system, the position of most of the auriferous strata of Great Britain and Australia, and, it is supposed, of Nova Scotia. We may further remark, as indicating a region worthy of examination, that the rocks in the country north and east of St. Stephen, including the localities above alluded to, bear much resemblence to some portions of the auriferous coast-belt of the last named Province, more particularly about the district of Shelburne; these in both cases embracing fine grained gneisses, mica-slates (with crystals of staurolite

and garnet), and micaceous quartzites traversed by granitic veins. Over the area occupied by these rocks in New Brunswick white quartz boulders of large size are often met with, and more rarely, (as in the instance above given,) the veins from which these latter have been derived; the veins having in some cases a thickness of from eight to ten feet. A few miles northward of the same district (northern Charlotte and southwestern York Counties), are grey argillites, and fine grained grey sandstones and quartzites, very similar to the gold rocks which in Nova Scotia extend along the greater part of its Atlantic sea-board. Gold.

Near Randall's lime-kilns, on the L'Etang peninsula, in Charlotte county, are beds of quartzite, which according to an analysis made by Dr. Hayes of Boston, yielded an amount of gold equal to ten dollars to the ton. The association of this quartzite with the crystalline limestones of that region indicates that it may be of Laurentian age. The beds in the Laurentian area in St. John county, to which this is supposed to be equivalent, are the quartzites which appear at Hayward's kiln, on the east side of Musquash Harbor, and at Mill Creek, Pisarinco. The same silicious beds are better exposed in the range of ledges extending from the Upper Falls of the river near St. John, in the rear of Lily Lake, to and beyond Drury's Marsh.

COMBUSTIBLE AND CARBONACEOUS MINERALS.

Bituminous Coal.—Over the greater part of the region to which this report relates, no rocks more recent than those of the Lower Carboniferous series, or the marine portion of the Coal formation, are recognized. This mineral, therefore, has not been found, nor is it to be looked for in the district referred to. Small seams of coal are sometimes met with in connection with the Carboniferous rocks along the coast, in the eastern part of St. John and Albert counties, but are too insignificant to require special notice here. In the larger Carboniferous area of the interior, coal seams occur at several points, the largest, twenty-two inches in thickness, being that of Grand Lake, in Queen's County. As this region, however, is beyond the limits of this report, and has not yet received a thorough examination, we forbear to make any observations on its probable productiveness. Coal.

Anthracite.—Small seams of this variety of coal are not infrequent in the Dadoxylon sandstones of St. John County. At Lepreau Harbor, a bed of slaty anthracite from five to eight inches in thickness was observed. It is not impossible that deposits of commercial value may be met with Anthracite.

in some parts of the tract examined by us. The grey sandstones of western St. John County and the lower argillites of the Nerepis country offer the best indications of this mineral.

Bituminous shale.

BITUMINOUS SHALE.—The amount of bitumen yielded by the shales or pyroschists of King's, Albert and Westmoreland Counties is often large, and at times such as to render them available for economic purposes. The richest bed, known as the Black Band, at the Caledonia Works in Albert County, is capable of yielding 63 gallons of crude oil to the ton. Others, on the Memramcook River in Westmoreland, yield 37 gallons. The Black Band shales are also capable of yielding 7,500 cubic feet of gas per ton, or about one-half the quantity afforded by the mineral Albertite.

These shales extend in two or more parallel bands, over a considerable extent of country in the counties above named, but exhibit much diversity in the amount of bitumen which they contain.

Albertite.

ALBERTITE.—This valuable mineral has been observed at a number of points in connection with the shales above alluded to, but, with the exception of the original locality, near Hillsborough, has not been found in available quantities. From this latter there were removed 56,289 tons between the years 1863 and 1865, paying, during the same period, a royalty to the Government of $8,089.29. This exportation was principally to the United States, where the mineral was employed for the manufacture of oil and gas. It is said to be capable of yielding 100 gallons of crude oil to the ton, while of gas the yield is 14,500 cubic feet of superior illuminating power. In consequence, however, of the large production and consequent cheapness of native oils in the United States, the amount of this mineral extracted from the Albert mines has of late years been materially reduced.

Remarks on the nature and mode of occurrence of Albertite will be found in the second edition of the Acadian Geology of Dr. Dawson, page 231.

Peat.

PEAT.—Extensive deposits of this substance occur in several portions of the southern and southwestern counties. They present the same features as those described in the province of Quebec (Geology of Canada, 1863, page 771), and may, like these, become available for fuel or purposes of distillation. No examinations have been made to ascertain the thickness or quality of any of these deposits. The largest noticed by us are those of the Mispec Barrens, in the parish of Simonds, St. John county; along the coast between Musquash Harbor and Mace's Bay; among the hills between the latter and Passamaquoddy Bay, and inland on the line of the St. Stephen Branch railway, near Meadow station, and about the head-waters of the Dennis Stream, north and east of St. Stephen.

Graphite.

GRAPHITE OR PLUMBAGO, in a finely divided state, is not unfrequently disseminated through the more altered rocks of the southern counties, imparting to certain members of them a dark color and glossy lustre, and at a few points is found in beds available for economic purposes. The largest of

these are in connection with the rocks of the Laurentian system, in the vicinity of St. John, appearing at the Narrows of the St. John river, Lily lake, and other points. Within a few years mining operations, (for some time discontinued,) have been renewed in this vicinity, and 2,000 barrels of 300 pounds each of plumbago are said to have been removed from a single opening at the Straight Shore (Portland) within two years, The old openings at the Falls were re-opened in the autumn of 1868, by Mr. A. Garritt. At this mine, known as the Split-Rock Plumbago mine, the facilities for mining and shipment are all that could be desired. The mineral is extracted chiefly from one principal bed, with lateral deposits of minor importance. The mines are capable of producing 100 barrels daily. The average amount per diem now being removed is about 25 barrels. Operations were commenced here on the 20th of November, 1868, since which time about 6,000 barrels per year have been removed, averaging four cwt. crushed and screened, to a barrel. Mr. Garritt states that there is no diminution of the supply, and that the quality of the mineral is better now than when he began operations. Though too impure for some of the uses to which graphite is applied, it has been found to answer well for foundry-facings and for the manufacture of stove-polish. Graphite.

No effort has yet been made to trace these graphitic bands. They occur in argillites and sub-crystalline limestones, and vary from one to four feet in thickness. The entire mass of these limestones is sometimes of a dark grey or greyish-black color from the fine dissemination of this mineral, which may occasionally be discerned in the form of dark imbedded laminae.

MATERIALS FOR LIME AND PLASTER.

Limestones. LIMESTONES AND DOLOMITES. The most important beds of limestones in southern New Brunswick are those occurring in connection with the Laurentian system in St. John County, forming thick deposits about the Narrows of the St. John River and in the extension of the same band of rocks eastward and westward of that stream.

These limestones vary greatly in color, texture and composition, including magnesian as well as ordinary limestones, and exhibiting every shade from a pure white to one in which, from disseminated graphite, the color becomes nearly black. These darker varieties are those in which the principal lime-quarries near the city of St. John have been opened. Ten of these quarries are now in operation, and the amount of rock annually

calcined is large. A description of the position and relations of the more important calcareous bands in this region will be found in connection with our remarks on the Laurentian system.

Limestone.

On the L'Etang peninsula, in Charlotte County, are heavy beds of bluish-white striped limestone, breaking into rhomboidal fragments, from which, for many years, considerable quantities of excellent lime have been prepared. The same band of calcareous rocks extends across L'Etang Harbor to Frye's or Cailiff's Island, where also there occurs a thick bed of magnesian limestone or dolomite.

Beds of comparatively thin and generally impure limestones are found in some portions of the Coastal group of Huronian rocks; but have only been employed locally at the points where they occur. The purest varieties seen were in the rear of the farm below Belyea's inn at the mouth of the Nerepis River; near the Roman Catholic chapel in the village of Lancaster; on the eastern side of Lepreau Basin, and for a mile or two eastward therefrom; and on the hill north of the swale terminating at the head of Dipper Harbor. A remarkably pure and white carbonate of lime was observed on the slope of a hill south of the same depression, but its quantity is probably not large. On Kent's Island, the outer of the group of the Three Islands off the southern shore of Grand Manan, are beds of white and pink crystalline limestone, containing a considerable admixture of quartz.

Besides the beds of limestone above alluded to in the Coastal group, beds of yellowish-grey dolomite, which are sometimes crystalline, but usually more or less impure and earthy, occur in connection with the Huronian series in the northeastern part of King's County. The best principal localities of it noticed by us are the vicinity of Tenant's Cove on the St. John River in the parish of Kars, and on the tributaries of Pascabec River, north of Callina Corner, in the parish of Springfield. Impure dolomites are also met with among the older crystalline schists on the island of Grand Manan and the adjacent islands.

Among the strata of the Lower Carboniferous series limestones are of frequent occurrence, but are often impure, and are employed only for local use. The distribution of these calcareous beds has been given on preceding pages.

Gypsum.

GYPSUM.—In connection with the limestone of the Lower Carboniferous series, beds of gypsum are met with at various points, and at times form deposits of considerable thickness. Of these, the most important are in the vicinity of Hillsborough, in Albert county. The beds of this locality are sixty feet thick. They consist in part of ordinary gypsum, and in part of anhydrite, which pass into each other; while scattered through the mass, small crystals of selenite are sometimes met with. This deposit has been worked for a number of years, and large quantities have been removed, the product being transported by rail to Hillsborough, and there calcined for exportation.

Other heavy beds of gypsum, but less pure than the above, occur in Sussex, Upham and Salisbury.

GRINDING AND POLISHING MATERIALS.

Sandstones of superior quality for the manufacture of millstones and grindstones, may be obtained among the rocks of the Lower Carboniferous or Millstone-grit series, near the head of the Bay of Fundy. (Dawson, Acadian Geology, 2nd edition, page 154, 249.) Quarries have been opened in these rocks at several points about Shepody Bay and on Grindstone Island. Grindstones & millstones.

Some of the gneissic or granitoid rocks of the Laurentian system and the Nerepis granites may be available for the manufacture of millstones. Materials suitable for this purpose or for polishing are probably to be met with also among the sandstones, micaceous quartzites and petrosilicious rocks of the Huronian and Upper Silurian series.

BUILDING STONES.

Under this head may be included: first, feldspathic rocks, such as granite, syenite, gneiss etc.: and secondly, sandstones, limestones, marble, flagstones and roofing-slates.

Granites, etc.—As previously shown, much of the so-called granite in southern New Brunswick exhibits traces of stratification, and is more properly a gneiss than a true granite. The latter, however, is also abundant, and both by the addition of hornblende often become syenitic, or by the absence of both mica and hornblende, a granulite or eurite. These rocks shade into each other by insensible gradations, and, for economical purposes, may be regarded as constituting a single group. Granites.

Details have already been given of the distribution and character of the grey granitoid and hornblendic rocks of the Laurentian system and their probable equivalents in western Charlotte and Queen's Counties, as well as of the red or tawny feldspathic rocks of the Nerepis range. Both series afford excellent materials for architectural purposes. In the last named range quarries have been opened near the Eagle Cliff, along the line of the European and North American railway (Western Extension), and a stone of fine quality extracted. Equally good granite occurs in other parts of the same series. The granites of the Laurentian system are generally darker, tougher, and from containing iron more liable to rust than those

last noted, but many of these also are available. At Hampstead in Queen's County, quarries have been opened in beds resembling those of this series, and considerable quantities removed. The rock at this locality has been exposed to a depth of about fifty feet, and is of a uniform pale grey color, very homogeneous in texture, though occasionally containing darker hornblendic masses, and is easily obtained in blocks of any required magnitude. Near Oak Point on the St. Croix River there are also thick beds of light colored granites, probably belonging to the same formation, which have been quarried to some extent, especially on the western side of the river. The facilities for shipment at both of these localities are good.

Sandstones.

SANDSTONES, of various texture, color and hardness, are abundant through the southern counties. Those best adapted for building are the olive-grey freestones of the Lower Carboniferous or Millstone grit series in Albert and Westmoreland Counties, which are of superior quality. The beds are generally even and the rock fine-grained, uniform and easily dressed. Though often soft when freshly quarried, it hardens upon exposure and is very durable. Several quarries have been opened in these rocks about Shepody Bay, and large quantities of stone removed.

Some of the sandstones of the Huronian, Upper Silurian and Mascarene series, appear also to be well adapted for architectural purposes. Such, for example, is the case with the reddish freestones found at Lepreau Village, and in the country to the east and south of that place. The Dadoxylon sandstone of St. John County, which is of a grey color, may also be sometimes suitable for such purposes, though its great hardness frequently constitutes an objectionable feature. The same is true of the sandstones so abundant in western Charlotte, which are also rendered irregular in texture by the presence of epidotic matter, and by a tendency to a vesicular or amygdaloidal structure.

The sandstones of the coal-measures are generally soft, more or less pyritous, and apt to crumble on exposure. Beds of finer texture are however, sometimes met with. On Three-tree Creek, near Hartt's Mills in Sunbury County, a quarry has been opened in a handsome grey rock, of uniform texture and mostly free from iron, which has been employed in the construction of the Fredericton Branch railway.

Limestones.

LIMESTONES.—Reference has already been made to the occurrence of limestones and dolomites in connection with their application to the manufacture of lime and cements, and in the body of the Report full details have been given of their character and distribution. Some of the beds would undoubtedly yield good materials for building purposes, but little effort has as yet been made to test their quality in this respect. They occur for the most part in connection with the Laurentian system of St. John County, especially about the Narrows of the St. John River, and in the parish of Portland.

Marbles.

MARBLES, of several shades of color and varieties of crystalline texture,

occur in the same region. These are often too much shattered to be of value, but more compact beds are sometimes met with, which may be capable of employment for decorative purposes. Their beauty is frequently increased by an admixture of serpentine, either in bands or grains, of yellowish-green to dark green colors. Very beautiful hand-specimens of the latter may be ha l, but blocks large enough for ornamental uses are more difficult to obtain. The best localities within the district examined are at and near the Narrows of the St. John River, and along the Pisarinco shore north of Mill Cove. Serpentine.

FLAGSTONES.—Materials suitable for flagging, though not of common occurrence in the southern counties, are nevertheless sometimes met with. Among the argillites and sandstones of the St. John or Acadian group, many of the beds contain layers available for this purpose. The same is true of the grey argillite series of northern Charlotte County, and of the mica-slates and micaceous quartzites of Moore's Mills, and the region north and east of St. Stephen. Some portions of the first named series naturally break into large tabular blocks well adapted for this use. Flagstones.

ROOFING-SLATES. The only slates suitable for roofing which have met our notice, are in connection with the pale grey micaceous argillites of northern Charlotte aed Queen's Counties. Through most of the country south of the granite hills, the flexures of the beds are too numerous and the dislocations too frequent to admit of the employment of the argillites which are there found, for such purposes; but on the north side of the same hills, the dips are more regular, and the cleavage better defined. A band of pale grey slates, which are more or less micaceous, and apparently well adapted for roofing, extends through the northern part of Charlotte County eastwards into Queen's county, and is well exposed in Basswood Ridge, Scotch Ridge, Oak Hill etc., as well as in Jerusalem Settlement and at Hampstead on the St. John River. Roofing-Slates

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ORNAMENTAL STONES.

In addition to some of the granites, marbles and serpentines, which may be employed for decorative as well as for architectural purposes, we may allude as adapted to a like use to some of the feldspathic rocks noticed by us in the form of veins, as well as to the felsites and porphyries, which are so abundant in some portions of the district examined.

GRANITES, ETC.—There are in some parts of the range of intrusive granites extending from the Digdequash River in Charlotte County, through the Nerepis hills, to the St. John River in Queen's County, masses of red syenitic rock which appear to be well adapted for ornamental purposes. Some Granites.

portions of this rock may compare favorably in depth and richness of color, with the highly esteemed red granite of Scotland, and are certainly worthy of more attention than they have yet received. The best varieties noticed by us were in boulders derived from the red granite hills about Lake Utopia and the Magaguadavic River in Charlotte county.

Red granites.

A peculiar variety of granite, in which the feldspar crystals are variegated with red and white tints, is abundant on the West Musquash River, near Sherwood Lake, and again on the Northwest Branch.

Veins of albitic granite are sometimes found associated with the rocks of the Laurentian system, as near the city of St. John and about Foster's Lake in Charlotte county, portions of which would probably be very handsome if cut and polished. Some of the labradorite rocks already noticed may be suitable for building or ornamentation; but no rocks presenting large cleavable masses of labrador feldspar such as are found in Ontario and Quebec, have been met with here.

Porphyries.

FELSITES AND PORPHYRIES.—Among the feldspathic rocks which constitute so large a portion of the Huronian and Mascarene series in the south-western counties, beds are frequently to be seen, which, from uniformity of texture and beauty of color, suggest their application to purposes of ornament. No attempt, however, has yet been made to test the qualities of any of these rocks. The richness of their colors, varying from a bright red to brownish-red, frequently variegated or mottled with spots and bands of different tints, their abundance, and the readiness with which they may be obtained, are such as to make trials with this object in view desirable. Beds of this character were observed about the Chamcook Lakes, along the line of the St. Andrew's and Quebec Railway, as well as to the eastward of the latter, about Bocabec, Digdequash, and Magaguadavic.

The beauty of these felsites is often much increased by their containing imbedded crystals of similar composition, thus becoming porphyries. These crystals are usually a shade of red, sometimes lighter and sometimes darker than the matrix. Green crystals have also been observed. Many of the beds above alluded to have this porphyritic character, especially near Lake Utopia, where they constitute the eminence known as Troak's Mountain; also on the Mascarene shore, and some of the Western Isles.

A handsome variety of feldspathic rock, having large imbedded hexagonal crystals of feldspar, zoned with red and white colors, occurs at the mouth of Seven-mile Lake Brook, on the West Musquash.

In connection with the metamorphic rocks of Albert County, porphyries are sometimes met with, having large irregular crystals of a whitish color in a grey or bluish-grey feldspathic base. Somewhat similar porphyries also constitute beds among the petrosilicious strata of the Huronian series in St. John and Kings Counties, and upon the smaller islands adjacent to the Island of Grand Manan.

MINERAL SPECIES

We conclude this Report with the following list of mineral species observed by us as occurring in the district examined, some of them being characteristic of the groups of rocks in which they are found :— Mineral species.

1. Carbonates of Lime and Magnesia.

Calcite.—Much of the limestone occurring in connection with the Laurentian system is sparry, but distinct and well defined crystals are seldom met with. These are more commonly found in veins of this and the more recent formations. The varieties are dog-tooth spar, nail-head spar and also hexagonal and rhombohedral crystals. A deep red calcite constitutes some veins along the coast, as at Chance Harbor, Sheldon's Point, Martin's Head; and elsewhere. At Goose Creek, near the last named promontory, large rhombohedrons of calcite fill crevices in Lower Carboniferous conglomerates.

Arragonite.—In a mass of very pure white limestone, probably deposited by infiltration, in a cavernous fissure of the conglomerates at the head of Dipper Harbor, a structure resembling that of this species was observed.

Dolomite.—Found massive in beds connected with the Laurentian system in St. John County, and at L'Etang and Frye's Island in Charlotte County ; also in connection with rocks of the Huronian series in the parishes of Kars and Springfield in King's County, and upon the Island of Grand Manan. Crystals of pearl-spar, with some combined carbonate of iron, are found in slates at Musquash Harbor, and with calcite, barytes, limonite and pyrolusite, in the manganese mine at Markhamville, King's County.

Magnesite.—A vein composed of this mineral, several feet wide, occurs on the bay-shore of St. John County, near West Beach, in connection with a gray chloritic schist.

Heavy-Spar.—Heavy-spar or sulphate of barytes occurs in veins with calcite, purple fluor-spar and galena, intersecting limestones at Frye's Island ; in veins, from one inch to four feet in thickness, north of the Swallow-tail light on the Island of Grand Manan ; also in small quantities with calcite and pyrolusite at Markhamville, Kings County.

Fluor-Spar.— Purple fluor-spar is found as just mentioned on Frye's Island, with calc-spar and barytes ; and also in compact white masses, in veins, mingled with quartz. A green variety occurs with amethystine quartz and copper ore, at Bclleveaux's Mill, Beech Hill, Westmoreland. Small purple crystals occur in the Lower Carboniferous limestone of Upham, King's County.

Gypsum.—See page 313. The principal localities are the following :— Near Hillsborough, Albert County, in thick beds ; near Sussex, King's County, also in thick beds ; near Apohaqui, Kings County, and in the valley of the mill-stream ; on the road from Quaco to Sussex, at W. Baird's (large bed) ; North River, Westmorland County ; Martin's Head, St. John County.

Mineral species.

Large groups of selenite crystals, remarkable for containing sand, have been obtained from near Sussex, and appear to be still in process of formation.

ANHYDRITE.—Occurs with the last at Hillsborough and elsewhere.

HORNBLENDE.—Abundant as a constituent of certain rocks in the Laurentian system, and in the various groups of the Huronian series. A fibrous, radiating asbestiform variety constitutes beds of some thickness about Moore's Lake, in Charlotte Connty. The variety termed actinolite has been observed at Burke's Cove, in the Narrows of the St. John River, and the variety asbestus in veins with epidote, at Sheldon's Point, St. John County; also in veins at Martin's Head, in the same county, and on Frye's Island in Charlotte County. The variety tremolite frequently occurs in the white Laurentian limestones of St. John County, at the Narrows, and elsewhere.

PYROXENE OR AUGITE:—With labradorite and hypersthene in the anortholite rocks of Dolin's Lake, St. John County; also abundant as a constituent of the trappean rocks in the New Red sandstone, Lower Carboniferous, and older formations, more especially on the Island of Grand Manan. At Dolin's Lake are found large cleavable crystals of hypersthene, from one to two inches in length. The variety diallage occurs in schistose dioritic rocks with serpentine near St. Stephen.

TALC.—Compact talc or steatite has been observed at several points in small quantities, in connection with the rocks of the Laurentian system, as in the Narrows of the St. John River, near Musquash, and elsewhere.

SERPENTINE.—Pale green varieties of this mineral occur in admixture with limestone, in the Laurentian district of St. John County, as in Portland, at Lily Lake and Pisarinco, forming an ophicalce. Numerous thin layers of a dark green serpentine, holding small quantities of chrome and nickel, are contained in schistose diorites near the town of St. Stephen. The fibrous variety picrolite covers the surfaces of cracks in the same rocks. Another variety, chrysotile, forms veins in the pale green serpentine of Pisarinco, about one mile north of Mill Creek; also in the serpentine limestones near Lily Lake and in the parish of Portland.

ORTHOCLASE.—Red feldspars of this species, are abundant, especially in the intrusive granites of the Nerepis range, being sometimes alone, but more commonly associated with quartz, mica, or hornblende, forming granites, syenites, eurites, etc. No analyses of these feldspars have been made.

Veins composed in part of orthoclase crystals, which are imbedded in chlorite, occur in the rocks of the Kingston group at Clifton, the Land's End and New River. At Moosepath, near St. John, a vein, consisting of quartz and white orthoclase feldspar, with large crystals of black tourmaline, is found in micaceous schists adjoining a limestone quarry.

ALBITE.—In granitic veins in the Laurentian system.

LABRADORITE.—In the anortholite rocks of Dolin's Lake, St. John County,

this species is abundant, and associated with hypersthene and pyroxene. This also is probably the common feldspar of most of the fine grained dioritic rocks so frequent in the Huronian series. Mineral species.

ZEOLITES.—Species of this group of minerals are rare on the main land of New Brunswick, but are sometimes found filling cavities in amygdaloidal rocks connected with the Lower Carboniferous and older formations. Crystals of reddish heulandite are thus met with at Hampstead, in Queen's County, about Chamcook Lake and the St. Croix River, in Charlotte County, and elsewhere. Prehnite has been observed on the Kennebecasis River, in connection with rocks of the Kingston group, and laumontite at Quispamsis. In the trappean rocks of the New Red sandstone on the Island of Grand Manan, zeolites are more abundant, and embrace several species, such as stilbite, apophyllite, &c., but usually in smaller and less perfect crystals than in the rocks of the same formation in Nova Scotia.

CHLORITE.—This mineral is common in rocks of the Kingston group, where it is usually associated with epidote. Pure granular masses of chlorite of considerable size occur at Clifton, on the Kennebecasis. A pale green talcoid variety is abundant as a constituent of some of the coarser rocks in the Coastal group of the Huronian series.

TOURMALINE.—The black variety of this species has been noticed at the mines on theMascarene shore, in small crystals penetrating quartz. In the red friable granites of Fall Brook and Douglas valley in Queen's County, groups of black tourmaline crystals fill cavities in the rock, associated with fluor and a greenish hydrous mica. Crystals of black tourmaline of considerable size occur in veins of translucent quartz cutting the mica-schists at Moore's Mills; and also in a granite vein with white orthoclase and potash-mica (muscovite) in the mica-schists at Moosepath, near St. John.

MICAS.—These are common as constituents of thesome of the crystalline stratified rocks, but mostly in small scales or crystals. No analyses of any of these micas have been made. With few exceptions those noticed by us are dark colored and probably belong to the species muscovite. Very pure mica-schists of a silvery and more or less talcoid aspect occur in some parts of the Kingston group, as at the Land's End in King's County, and in those of the Coastal group, in eastern St. John and Albert Counties. Besides the muscovite mentioned above as occurring with tourmaline at Moosepath, crystals of a yellowish variety, an inch or more in diameter, are found with white orthoclase and quartz, forming a coarse granitic vein in the mica-schists at Moore's Mills.

GARNET.—Small crystals of dark red garnet abound in some of the beds of mica-schist at Moore's Lake interstratified with the beds holding crystals of staurolite.

EPIDOTE.—This mineral occurs with chlorite, in groups of interlacing prisms of a pale green color, at Clifton, parish of Kingston, and at the Land's

Mineral species.

End, parish of Westfield, King's County; also at New River and Beaver Harbor, in Charlotte County, in each case in connection with rocks of the Kingston group. Epidote, in more or less crystalline masses, is also frequently met with in veins penetrating granitic rocks of the Laurentian system about Grand Bay, in St. John County. About Chamcook Lake, and on the St. Croix River, in Charlotte County, it often covers the surfaces of the rock in joints, both in the red granites and crystalline felsites there met with, as well as in the overlying sandstones of the Mascarene series, often in connection with masses of intrusive diorite. At Sheldon's Point, in St. John County, the species zoisite is found in fibrous masses of a pink color, associated with pistacite and asbestus.

Staurolite,—The mica-schists of Moore's Lake, near to Moore's Mills, in Charlotte County, contain this species in great abundance, the crystals being often large, but seldom with perfect terminations.

Andalusite.—This mineral, in crystals of a pale flesh-red color, and from two to four inches in length and half an inch or more in diameter is met with at Moore's Mills, in beds of a fine-grained micaceous schist belonging to the same series with those holding staurolite and garnet, and adjoining them. The rock is somewhat disintegrated and iron-stained, and the crystals are coated with mica, but when cut across are found in many cases homogenous and translucent. Some specimens however exhibit the peculiar macles of the variety called chiastolite.

Quartz.—Veins of milk-white quartz, often of considerable thickness, are common in some parts of Charlotte County, and boulders derived from the same are of frequent occurrence. With these veins the transparent variety termed rock-crystal is sometimes met with. Small crystals of the latter fill veins in a coarse quartzose conglomerate at Diamond Hill near the village of Lancaster on the Musquash River; also at West Beach and Black River, east of St. John.

SUPPLEMENTARY REPORT

ON THE

GEOLOGY OF

NORTHWESTERN NEW BRUNSWICK.

BY

CHARLES ROBB, Esq.,

ADDRESSED TO

A. R. C. SELWYN, Esq., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, 1st *May*, 1870.

SIR,—The geological explorations undertaken and conducted by me in 1868, in northwestern New Brunswick, at the request of Sir William Logan, were, for reasons stated in my Report, of a general rather than a systematic and detailed character. Accordingly, in the summer of 1869, with his sanction, I revisited the same region, with the view of investigating the conditions in greater detail, and with the aid of instrumental measurement. I have now the honour of submitting to you the result of these later observations, in the form of a Supplementary Report.

Surveyed lines. The principal lines of exploration thus surveyed may be described as a series of sections across the strike of the rock-formations; viz.: 1st. The section afforded by the St. John River from Fredericton to Grand Falls, (134 miles), including, at some points, the country adjacent to the river for a breadth varying from five to twelve miles. 2nd. A line nearly parallel to the river, at the distance of about fourteen miles to the northeast; being the new road from Fredericton to Woodstock, *viâ* Hayneville (50 miles). 3rd. The Nashwauk River (46 miles). 4th. The Taxis and part of the Southwest Miramichi Rivers (about 30 miles,) together with the lines connecting these various transverse sections.

Maps and plans. The details of these surveys are embodied in a series of sheets, herewith presented, plotted to a scale of two and a half inches to a mile, as also more generally in the larger of the two maps previously compiled. Through the kindness of Mr. Edward Jack, Surveyor, who has on previous occasions rendered me valuable assistance, I am enabled to present a topographical and geographical sketch and description of the Little Southwest Miramichi River, which cuts the rock-formations at the distance of about thirty miles to the northwest of the limits of my own explorations in this direction.

In the supplementary remarks which I have now to make, I propose to follow the order adopted in my previous Report.

1. THE CARBONIFEROUS AREA.

Upper beds.

The upper beds of this area, where examined by me, (consisting of grey, yellowish and purple coarse sandstones,) notwithstanding numerous local diversities, which seem due to false bedding, appear to possess, on the whole, a horizontal attitude. The southeasterly dip, at various angles, which for the most part characterizes the lower beds, seems also due to similar causes, and to be the result rather of the original deposition of the sediments on a sloping surface than of any subsequent disturbance of the strata. The sandstones which are sometimes associated with the red calcareous conglomerate in these lower strata, differ notably from those in the upper part, not only in the presence of calcareous matter, but in the greater predominance of the feldspathic over the arenaceous element in the composition of the matrix or cement. Their extreme liability to decomposition by atmospheric influences will render these beds, even where sufficiently massive, unsuitable for the purpose of building-materials.

Lower beds.

Eruptive rocks.

At the summit of the red calcareous conglomerate on the Southwest Miramichi River section, and also in the same stratigraphical position on the Taxis River, about four miles from the mouth, I have noted the occurrence of two additional eruptive masses of considerable extent; the latter, however, appears to be the continuation of that already described as seen near Clearwater Brook, on the road from Fredericton to Boiestown (Geological Survey of Canada. Report of Progress, 1866-69, page 186). The former is much more vescicular, and is especially characterized by the presence of much red heulandite, in cavities and in narrow seams. It is underlaid by beds of peculiar white and red clays, probably also of volcanic origin, and resembling respectively kaolin and bole. The following is a section, in ascending order, taken in a cliff about fifty feet high, rising from the bank of the river, where these earthy beds are exposed; the attitude of the whole being apparently horizontal:—

	Feet.
1. A pure white clay of unknown thickness from the level of the river; probably about	4
2. Red earth bed; may be suitable for a pigment	2
3. Trap rock, in horizontal layers, with numerous vesicles, holding calc-spar, heulandite, etc., the latter also in seams	8
4. Reddish-brown or purple conglomerate, with angular splinters	2
of the underlying trap rock, intermixed with various rolled pebbles...	2
5. Grey sandstone and loose materials to summit	34
	52

The eruptive mass extends upwards for about three-quarters of a mile on the river-bank, terminating at Porter's Brook, five miles from Boiestown. A little farther up the river, the red calcareous conglomerate is seen in a narrow band, but dipping at a high angle, as on the opposite side of the river; and is succeeded by the calcareous slate and quartzite, some of the beds of which, at the distance of not less than 300 paces from the conglomerate, have been quarried, and the rock burned in a kiln to a limited extent for lime.

Brighton outlier.

My explorations of last year included a further examination of the Brighton or Beccaguimic outlier of supposed Lower Carboniferous age, and which was noticed in general terms in my previous Report (see Reports of Survey, 1866-69, p. 197). Its northwestern outcrop, on the east side of the river St. John, together with its supposed continuation on the west side, as before described, form, so far as they respectively extend, the southeast limit of the great calcareous slate band; and its breadth appears to correspond approximately with that of the non-calcareous band next to the granite. Its total extent, as before remarked, is about sixty or seventy square miles. Throughout the greater part of its area its boundaries are defined, in a very remarkable manner, by the course of the north and south branches of the river Beccaguimic, which almost surround it. Its highest elevation is from 600 to 700 feet above the river. It terminates, at the St. John River, in a band of conglomerate only 560 yards wide. The only fossil forms which I have discovered in the outlier occur in a bed of dark green shale, dipping S.E. $< 60^\circ$, and holding, in great profusion, fossil vegetable forms of Devonian type, which Dr. Dawson has determined to be *Psilophyton princeps*. As no other fossils were found, this may be insufficient to mark the age of the outlier; and certainly, with this limited exception, its aspect is entirely that of the Lower Carboniferous.

Fossils.

Throughout the greater part of the area in question, the lowest stratum is a coarse red conglomerate, dipping N.W. at an angle varying from 20° to 30°. This conglomerate is in no respect distinguishable from that of the main Carboniferous area, or of the Tobique outlier, except that it is very sparingly if at all calcareous. Towards its northwestern outcrop it appears to be abruptly cut off, as if by a fault; and along this line, as in the above-cited cases, eruptive or igneous rocks are frequently interposed. The most remarkable of these occur at and near the mouth of a river called Pokiok, a tributary of the north branch of the Beccaguimic; where a mass of quartziferous pophyry, precisely resembling that of Cranberry Lake, near Harvey Settlement, York County. (Report of Progress, 1866–69, page 180), occupies the right bank for the distance of about half a mile. The colour is a bright red, inclining to purple, and on weathered surfaces, whitish from the decomposition of feldspar. It is bedded horizontally, sometimes massive, but more frequently cut up irregularly by numerous joints. The same kind of rock, with slight variations in mineral aggregation and mechanical

Igneous rocks.

structure, is displayed at several points farther up the stream, cutting hard blue silicious slates, and producing a succession of falls and rapids. The south branch of the river forms the boundary of the outlier in the opposite direction; it is characterized at some points by similar exposures; and towards the southeast limit of the outlier the beds of the streams are frequently strewn with red granite debris, indicating the proximity of that rock, although it was not actually seen in place.

Overlying the red conglomerate, to the extent of about 180 feet in thickness, are red, fine-grained arenaceous shales, succeeded by a siliceous conglomerate resembling that of the main Carboniferous area, the pebbles being almost entirely of quartz, and generally but little water-worn. This bed may be estimated at 50 feet in thickness. Then, to the summit, say 420 feet of white and yellowish tolerably fine-grained sandstone in horizontal beds, generally thin-bedded, but sometimes massive, and apparently well adapted for building purposes, unless the feldspar, which seems to enter largely into the composition of the paste, should prove an objectionable ingredient.

Minor outliers.

Outside the limits of the outlier, to the northwest, in Windsor Settlement, are several small isolated patches of unaltered sandstone and conglomerate, capping the eminences, and obviously minor outliers from the main area.

II. Slate Band South of the Main Granite Area.

Red slates.

In this division, I have to note the occurrence of a narrow band of red and green slate, on the river Nashwauk section, about four miles from the outcrop of the Lower Carboniferous rocks; and on the Taxis, of a similar band, much better defined and wider, being at least 600 paces in width, within two miles from the same outcrop. With reference to the general strike of the rocks, the former would correspond nearly with that previously noted, on the Southwest Miramichi, (Report of Progress, 1866–69, page 192), and also with that recently observed by Mr. Jack on the Little Southwest Miramichi; but the latter is very considerably to the southeast, and I was unable to detect any facts which could bring them into correlation. All the red and green bands dip to southeast. Bright green slates, much seamed with quartz veins, were also observed near the main forks of the Taxis River, and much red slate and granite debris at the same point; but no granite in place was seen on this river, although I ascended considerably beyond the point where such rocks had been observed on the Miramichi, about ten miles distant on the strike to the northwest. Occasionally, although rarely, I observed on the St. John and Taxis Rivers narrow bands of a granular dark-green sub-crystalline rock, resembling those which occur in such profusion on the upper St. John, sometimes

Dykes.

running obliquely to the stratification, and which I take to be dykes of a variety of diorite.

In surveying the Nashwauk River section, I devoted particular attention to that part where the band of fossiliferous ferruginous rock and the associated band of carbonaceous slate, as described at page 190 of my previous Report, would be exposed in that section, the distance being about three miles, on the strike, to the west. Both bands are well displayed in their expected positions, and preserve their respective characters, the former being 100 paces, and the latter 150 paces wide, both dipping S.E. < 60° ; but I was disappointed in being unable, after diligent search, to discover any organic forms in either. **Fossiliferous bands.**

These bands appear on the Nashwauk, seven-eighths of a mile below the mouth of the Napadaugan, one of its largest tributaries, immediately below which point occurs a breadth of 700 yards of grey, fine-grained, micaceous, imperfect gneiss, copiously seamed with quartz veins. Half a mile above the Napadaugan, true granite appears, being the commencement of the so-called central granitic band.

In a similar traverse along the new road from Fredericton to Woodstock, *viâ* Hayneville, I observed, on approaching the corresponding relative point, a narrow band of a felsite, or very hard and tough fine-grained quartzo-feldspathic rock. The same description of rock has been seen at so many different and distant points in the same relative position, that I think I am justified in stating that, so far as the central band is concerned, it invariably marks the passage from the sedimentary to the crystalline rocks. **Felsite.**

III. The Central Granitic Area.

In my previous Report, I described the rocks of this area as consisting of one broad band of granite, with gneissoid and other altered semi-crystalline feldspathic rocks irregularly distributed throughout its mass. My further investigations during last season have led to the recognition, at least in the region lying betwen the St. John and Miramichi Rivers, of two distinct and well-defined granitic bands, separated by another approximately parallel band of the character above specified. On the St. John River the breadth and limits assigned to the granite, considered as one belt, truly represent the aggregate of the three; the gneissoid rocks occupying a breadth of about two and three quarter miles, exactly intermediate between the extreme limits. On the Miramichi River the lower granite band is represented by the patch of that rock described as commencing about eleven miles above the Carboniferous outcrop; and extending thence, a distance of three and a half miles, to Snake Brook, from which point upwards, for the breadth of four and three-quarter miles, the gneissoid rocks prevail, giving place, near McDonald's Brook, to the upper granite band. (Report of Progress, 1866-69, page 193). **Gneissoid bands.**

The gneissoid rocks appear to attain their greatest breadth—six miles—on the line traversed by the new Woodstock Road through Hayneville; and the band is most contracted on the Nashwauk section, where it is scarcely a mile in width. On the west side of the St. John, the country in the immediate vicinity of the river, in continuation of the gneissoid band, is covered with a very deep drift, and in the interior is unexplored; consequently, I am unable to say whether these rocks form there as prominent a feature as on the other side of the river. They occur, however, mixed irregularly with the granite at many points in the continuation of the northern band of that rock.

Gneisses.

These so-called gneissoid rocks, while presenting a very considerable variety in colour, texture, &c., afford few characteristic marks by which, apart from chemical analysis, they can be classified or described. They rarely assume the form of true gneiss; being for the most part a very fine-grained, hard and tough aggregate of quartz and feldspar, generally though not always laminated, but with little tendency to break or split along the planes of the laminæ. The micaceous element, although not altogether wanting, is seldom very conspicuously displayed; some of the bands are characterized by the presence of hornblende, and nearly all by abundance of iron pyrites; others are black, resembling altered carbonaceous schists. They do not appear to me, from mere inspection, to differ specifically in mineral character from those occurring beyond the limits of the granite, both to the northwest and to the southeast. In stratigraphical attitude also, I could observe no marked difference, although in both cases this is difficult to determine, where the only indications presented show invariably an almost vertical dip; unquestionably the strike is in both cases the same.

In immediate proximity to the granite, these gneissoid rocks, like those outside of its limits, exhibit a tendency to the segregation of their component minerals into separate bands; but the true relations of all these schistose rocks to the granite are perplexing, and have not yet been satisfactorily established. The remarkable fact of angular fragments of the gneissoid rocks being frequently found imbedded, as it were, in the granite, seems undoubtedly to point to the posterior origin of the latter, whether it be regarded as an eruptive or altered sedimentary rock, and is irreconcilable with the notion of its greater antiquity.

On the left bank of the St. John and Miramichi Rivers respectively, there occur two isolated masses of granite, near the centre of the gneissoid band; judging from the apparent dip, in the latter case at least, the granite appears to lie in a synclinal trough of the surrounding schistose rocks.

With respect to the granite itself, I have noted the following additional particulars. Where the change occurs from the slate to the granite, and especially where the former (as is generally the case in such positions) is highly ferruginous, the granite in immediate proximity to the line of contact

is almost invariably of the red variety, and rather fine-grained, gradually passing into the ordinary colour and texture as we recede from that line. On the Nashwauk section, on first approaching the granite from the south, I observed it to be impregnated with a peculiar soft green steatitic or magnesian mineral; and frequently the quartz has a greenish hue, which may be due to the same cause. The granite presents at many points the appearance of lying in horizontal layers or beds, but this I attribute to some superficial causes connected with the weathering. Granite.

In my examination of the granites of the region, I regret that all attempts to elucidate their structural relations from what may be called internal evidence have proved futile. No definite attitude in the masses, nor regularity in the direction of the joints, etc., could be detected; nor any peculiarity in the arrangement or aggregation of the component minerals which might throw any light upon this point. The rock is generally coarsely crystalline, or rather sub-crystalline; the feldspar in parts all red, passing into red and white, in perhaps equal proportions, and then becoming entirely white; the quartz limpid and vitreous; the mica black and generally very sparingly diffused. Occasionally streaks of red colour appear in the masses; but neither joints nor streaks of colour coincide or approximate in direction with the general strike; and nothing is presented to indicate the relations of the granite to the schistose rocks.

IV. Slate Band Northwest of the Granite.

The rocks of this division, the extent and limits of which I have not found occasion to change from those stated in my previous Report, seem however, on a more comprehensive survey, to be susceptible of some modifications in regard to their description. Formerly no important distinction was recognised between them and the series on the other side of the great granite bands. I have now, however, to note some points which may mark a specific difference. The most important of these are:—1st: The prevalence, throughout the whole band, of a greenish colour, due probably to the presence of chlorite or epidote, or of both these minerals. 2nd: The predominance of the feldspathic element in their composition, causing them frequently to weather to a whitish or cream colour. 3rd: The scarcity of the schistose in comparison with the compact bands; and 4th: The occurrence of numerous beds or conformable dykes of diorite, syenite and other subcrystalline feldspathic rocks, sometimes metalliferous; and of thick veins of quartz, which also occasionally yield metallic ores. All these conditions seem to me to mark a more highly metamorphosed or altered state of the entire series, as compared with the other, although there is no apparent want of conformity. Greenish slates.

Limestone.

Immediately at the junction of the granite with the rocks of this series, there occurs near Canterbury station on the New Brunswick and Canada railway, a band of unknown thickness of tolerably pure crystalline limestone, of a laminated structure. As nothing is seen of any rock of this description in the corresponding point on the St. John River section, about eight miles distant, where the rocks are well exposed, it is to be presumed that this is a limited and probably a lenticular mass. A few miles farther north, however, on the St. John River, a remarkable band of highly calcareous slate, 550 yards wide, is seen, and similar rocks were observed at great distances on the strike, both east and west. In this case, the slates are calcareous and finely laminated, but contorted, resembling those so largely distributed on the upper St. John; with much calcareous spar diffused in the laminæ, and holding also small masses, and sometimes veins of limestone, generally lenticular, and elongated in the direction of the laminæ, but sometimes nodular and rounded. The calcareous masses contain much iron pyrites, as do also the enclosing slates, although to a less extent. I mention more particularly these circumstances (which are quite exceptional as regards the general character of the rocks of this section) because they appear to me to afford a key to the mode of occurrence, generally more obscure, of most of the masses of limestone throughout the great calcareous slate band to the north of Woodstock.

Graptolites.

I may here refer to the accidental discovery, in the neighborhood of Canterbury station, above mentioned, of a few distinctly characterized forms of graptolites, in a loose but angular block of ferruginous feldspathic sandstone, identical in appearance with many of the bands of rock in the vicinity. They were too obscure to denote the species; and as no such forms have been found in the fixed rock, the only significance attributable to this discovery is the fact that these forms do actually occur in rocks apparently identical with those of the country.

Some of the railway-cuttings north of Canterbury station have exposed several tolerably thick veins of quartz, highly charged with pyrrhotine or magnetic iron-pyrites; but although rumours were current of more precious metals having been discovered in this section, I was unable to authenticate them. I may remark, however, that this appears to be the metalliferous band of the country, and that it is in its continuation to the northwest that the extensive tracts of land on the Serpentine and Wapskehegan, mentioned in my previous Report, page 204, as having been leased for gold-mining purposes, are situated.

I have already in that Report (page 196) referred in general terms to the assemblage of crystalline rocks in the neighbourhood of Woodstock. They are very fully mapped and described on the detail sheets, and it may not be necessary to enter here upon a minute description. Some of them are apparently of igneous origin,

They are probably connected with the occurrence here of the continuation of the Lower Carboniferous outlier (Report of Progress, 1866-69, page 197). The trappean rocks are generally interbedded with those of an altered sedimentary character; and these distinct descriptions of rocks seem gradually to merge into each other, as if the former derived their peculiar characteristics only from a higher or more intense degree of metamorphism, in some cases amounting to complete fusion.

V. Calcareous Slates in Carleton and Victoria.

Organic remains.

With regard to this division I have to mention that specimens obtained by me of some of the limestones from Pole Hill, (in Brighton parish, Carleton County, close to the confines of the Lower Carboniferous outlier,) have been examined microscopically by Dr. Dawson, and chemically by Dr. Hunt, and found to consist of a mass of crinoidal stems and other organic remains; the pores of the crinoids being injected by a greenish-white crystalline hydrated silicate of alumina, magnesia and protoxyd of iron. This occurrence, which by Messrs. Dawson and Hunt is considered to throw light on the mineralization of Eozoon Canadense, and of more recent foraminifera, is described by them, with analyses, in the American Journal of Science for 1871. (Vol. 1. page 370.)

Dioritic rocks.

In my previous Report, I have described (Report of Progress, 1866-69, page 199), under the name of non-calcareous quartzite, a very extensive series of bands characterizing this division, generally conformable, but sometimes appearing to cut the rocks transversely or obliquely to their strike. A fuller examination of these has led me to the conclusion, either that they are of an eruptive nature, or if sedimentary that they have undergone exceptional modifications in their attitude and other conditions. They appear to me to partake of the character of fine-grained and imperfectly crystallized diorites or syenites, resembling those described as occurring in the previous division. In external appearance they differ but slightly from the enclosing rocks, but may be distinguished from them by being more granular in texture, harder and sometimes with conchoidal fracture, containing always more or less iron-pyrites, and having whatever little lime may enter into their composition, in the form of calcareous spar, in cracks, joints and veins, and not diffused throughout the rock itself. At one point on the main-river section, a little above the mouth of the Beccaguimic, I have counted not fewer than fourteen of these bands or conformable dykes, varying from three, to twenty feet thick, in a breadth of 200 paces. And again at White's Mountain near the mouth of the Aroostook, where they run transversely to the strata, and evidently proceed from

White's Mountain.

a nucleus in the mountain, the same number,—running nearly due east and west, all parallel to each other, and varying in thickness as above,—in a space of 800 paces. They sometimes appear to overspread and become entangled with the slates; but I could not detect in the latter any appearance of local alteration, such as might be expected to occur on the supposition of the apparently invading rocks being of a much higher temperature. These diorites are frequently found in contact with, or in immediate proximity to, the more highly calcareous masses, sometimes fossiliferous, which occur throughout this series.

Grand Falls.

The limit of my explorations of last season to the northwest, was the Grand Falls on the St. John River, about twenty miles above the mouth of the Tobique River. Between these points the rock-exposures are remarkably few; and when they do occur, differ very little in character from those lower down the stream, as already specified; it is therefore unnecessary to enter upon any more detailed description. At the Grand Falls, the whole of the waters of the St. John are precipitated over a perpendicular descent of seventy-four feet; and in a narrow semi-circular rocky gorge, of one mile in length, below the fall, reach the lower basin after a further descent of forty-five feet. The rocks consist of a dark-blue slaty limestone, or calcareous slate, ribboned; that is, by the effect of the atmospheric influences on the up-turned edges of the slates, they are weathered into alternating thin bands of different shades of grey, and furrowed according to the more or less decomposable character of the layers. There are many contortions, but the general strike seems to be about N. 60° to 70° E., dip N.W. $<$ 70°; sometimes however this dip is reversed, as might be expected. Some of the bands are pyritous, and all highly calcareous. In fact the rock has been successfully burnt for lime, although by no means a pure limestone.

VI. Tobique Valley and Tributaries.

Tobique region.

In my previous Report (Report of Progress, 1866-69, page 201), I referred to the fact of non-calcareous brown-weathering slates and quartzites or sandstones occurring in considerable volume near the mouth of the Tobique, and again near the Main Forks of the same river, a distance of upwards of sixty miles. In fact the whole of the Tobique Carboniferous outlier is probably inclosed in rocks of a similar description. These rocks resemble more nearly those described in the second section of my Report than any others in the whole series. They are totally dissimilar to those generally prevailing throughout the upper St. John region, and especially to those immediately in contact with them at the Narrows, and near the Forks of the Tobique, where they underlie them unconformably. Although I am unable to assign any precise limits to these different descriptions of rock formations, where they meet each other in the Tobique region, I am disposed provisionally to

class the non-calcareous brown-weathering rocks as identical with the metamorphic band which occurs immediately at the northern base of the main Carboniferous area of the Province.

I have the honour to be,

Sir,

Your most obedient servant,

CHARLES ROBB.

I append an abstract of certain geological observations on the Little Southwest Miramichi River, made towards the close of last season by Mr. Edward Jack. Their special interest consists in the fact that this river affords a section, transversely to the strike, of the same series of rocks described by me, at a distance of about thirty miles eastward of the limits of my observations in that direction, and in a region rarely visited and difficult of access. The general features of this section are identical with those already described. The coarse grey sandstones of the Carboniferous area extend four or five miles (measured across the strike) from the junction of the Little Southwest with the Northwest Miramichi; succeeded, for a breadth of about two miles, by the red sandstones, marls and conglomerate of the Lower Carboniferous, extending to the Blue Rapids, where these rocks are found dipping S.E. $< 10^{\circ}$, and resting on highly calcareous metamorphic slate, as previously described. Red slates, similar to those observed on the Main Southwest Miramichi and Taxis Rivers, were seen near the Devil's Brook, intercalated with the ordinary bluish-grey contorted slate and quartzite, which extends upwards for an entire breadth of fourteen miles, to within a mile and a half of the junction of the Middle North Branch, where, after an interval of about half a mile, occupied by very hard grey compact silico-feldspathic rock resembling petrosilex, the granite commences. **Mr. E. Jack's notes.**

Beyond this point, for a distance of twenty-four miles, as far as Serpentine and Gulquac Lakes (tributary to the Tobique), no rock was seen in place; but the numerous huge boulders, the quality of the debris and the aspect of the country, leave little doubt that this space, in which several lakes of considerable area are situated, is occupied uninterruptedly by granite.

C. R.

NOTES AND OBSERVATIONS

ON THE

GOLD FIELDS

OF

QUEBEC AND NOVA SCOTIA,

BY

ALFRED R. C. SELWYN.

Before coming to Canada, in October, 1869, I had spent the greater part of sixteen years immediately preceeding in Australia, chiefly in Victoria, noted as being the richest gold-producing country in the world. During that period, as Director of the Geological Survey of the Province, a large portion of my time and attention was devoted to investigating the geological relations and the structure of the gold-bearing rocks. I had also previously, as a member of the British Geological Survey, acquired an intimate knowledge of the gold-bearing Silurian and Cambrian rocks of North Wales; and as the gold-deposits of the Dominion have in the last few years attracted a good deal of notice, and a large amount of capital has been invested in their development, I considered it advisable to devote my first season in Canada to visiting some of the gold-producing districts, with a view of comparing them with those of the countries above referred to, and in the hope of being thus enabled to offer practical suggestions for their further development.

Chaudière, Quebec.

Other matters connected with the Geological Survey claiming my attention, I was not able to commence these examinations till towards the end of June, when I proceeded to the Chaudière, in the province of Quebec, from which river, and from its tributaries, nearly the whole of the gold which, up to the present time, has been produced in Canada proper has been obtained. None of it so far as I am aware, being the result of mining in the solid veinstone.

On making enquiry to learn what was being done on this gold field, I found that with the exception of desultory and occasional washing operations carried on by resident *habitans* on the superficial gravels in the beds of some of the tributary streams, the only works then in progress were those of

the Canadian and Northwest Land and Mining Company, under the immediate superintendence of Mr. W. P. Lockwood, to whose great kindness and readiness to impart information, I am very largely indebted for whatever I was able to learn in the neighbourhood, respecting both present and past operations ; as well as for facilities kindly afforded me in visiting all the most noted auriferous localities on the Chaudière and its tributaries, the Du Loup, the Famine, the Gilbert and the Des Plantes.

After spending about a week in these examinations, I proceeded *via* River du Loup, Temiscouata Lake and the Saint John River, to New Brunswick. My observations in this province were confined entirely to the St. John River, which I descended in a canoe. The unusually low water afforded excellent opportunities for examining the rocks along the course of the river, and by making this traverse I have acquired a general knowledge of the aspect and the succession of the formations between the St. Lawrence River and the northern boundary, near Fredericton, of the great central Carboniferous area of New Brunswick.

New Brunswick.

A considerable portion of this region in New Brunswick had recently been explored and reported on by Mr. Robb, under instructions from Sir W. E. Logan, and previously also in 1864, by Prof. H. Youle Hind and by Prof. L. W. Bailey, on behalf of the Local Government.

The little which has hitherto been done towards the discovery of gold in New Brunswick will be found stated in the reports of these explorers,* and the hasty traverse I made does not enable me to add anything of importance on this subject to what has already been stated by them. The rocks certainly present all the external characteristics usually met with in auriferous regions, and there is therefore every reason to hope that intelligently conducted "prospecting," if persevered in, might lead to the discovery of really valuable auriferous deposits. It is, however, quite impossible to arrive at any reliable or conclusive opinion on this matter without much more extended and careful research and exploration than has hitherto been made, but which I hope to be able to carry out on some future occasion.

Nova Scotia.

From Fredericton I proceeded to St. John, and crossing the Bay of Fundy, arrived in Nova Scotia on the 5th August. I was then continuously engaged till the 13th September, visiting and examining various gold districts in the counties of Halifax, Hants, Colchester, and Guysborough ; including Waverley, Oldham, Montague, Lawrencetown, Tangier, Mooseland, Musquodoboit, Mount Uniacke, Renfrew, Gay's River, Wine Harbor, Sherbrooke, and Isaac's Harbor.

On the 7th of October I was again in Nova Scotia, and was occupied

* Report of Mr. Charles Robb, 1869, on a part of New Brunswick, in Geological Survey of Canada, Reports for 1866-69, page 209. A Preliminary Report on the Geology of New Brunswick, &c., Fredericton, 1865, by H. Youle Hind, M.A., F. R G.S. Report on the Mines and Minerals of New Brunswick, by L. W. Bailey, A. M., Fredericton, 1864.

till the 4th November, examining the southwestern portions of the Province, the route followed being from Digby, *viâ* Weymouth, to Yarmouth, Tuskett, Barrington, Shelburne, Liverpool. Lunenburg, and the Ovens, Gold River, and Chester. From Chester, *viâ* New Ross, to Dalhousie Settlement, thence down the La Have River to Bridgewater, returning, *viâ* Liverpool, to Annapolis. Thus, so far as observations over so large an extent of country made in but little more than two months can enable one to do so, I have endeavoured to gain a general knowledge of the leading features of the geology, and of those affecting the economics of the gold-fields of Nova Scotia, which will enable me to compare them with the gold-fields of other countries, and which will also be extremely useful in conducting a detailed geological survey, such as is essential for the right comprehension of the geological structure of the Province, and by which alone, geology can be made to afford valuable assistance to the practical miner in developing its mineral resources.

Acknowledgements.

Before proceeding with the general and special remarks suggested by the facts to which my attention has been directed in the localities I have visited, I desire to tender my acknowledgements and thanks to the Hon. Robert Robertson, Commissioner of Mines, for his kindness in placing the resources of his department at my disposal. To Mr. John Rutherford, Inspector of Mines, and to Mr. John Kelly, Deputy Commissioner of Mines, my sincere thanks are due for much valuable and interesting local information, as likewise for the very cordial manner in which they gave effect to the instructions of the Commissioner.

The valuable information, and the kind attention which I received from Mr. H. Y. Hind have been most useful; and I am also much indebted to the various managers and agents of the mines which I visited, for the readiness with which they afforded me all the information and assistance in their power.

Previous reports.

The reports on the Waverley and Sherbrooke gold districts, in 1869, which have recently been published by Mr. Hind, under the authority of the Department of Mines; the report in connection with the Geological Survey of Canada, "On the Gold Region of Nova Scotia," by Dr. T. Sterry Hunt; the Acadian Geology, by Dr. Dawson; the "Mineralogy of Nova Scotia," by Prof. How; Mr. Heatherington's excellent "Guide to the Gold Fields of Nova Scotia," all published in 1868; together with the various reports by Messrs. Campbell, Silliman, Poole. and others, leave but little to be said either on the geology, or on the economics of the eastern gold-fields of the Dominion, which has not already been referred to, and ably discussed by one or other of these authors.

Veinstones.

In Canada, as in Britain, and in Australia, the known gold-bearing veinstone is confined to strata of eozoic, or palæozoic age; chiefly Silurian, but it is also occasionally found in crystalline rocks of later date, associated

with them in the form of dykes, veins, or masses. It consists commonly of vitreous, white opaque or milky quartz; but presents great variety in color, structure, and external appearance, dependant on its more or less ferruginous character, and on other circumstances connected with its position and mode of occurrence. It is almost without exception accompanied by mispickel, or by common pyrites; the sulphurets of lead, zinc, copper, antimony, and rarely bismuth are likewise characteristic accompaniments of many of the veins, as well as bitter-spar, calc-spar, sulphate of baryta, and other minerals, none of which, however, often occur in sufficient quantity to be of much importance.

The palæozoic strata in the gold districts with which I am acquainted, are always more or less intimately associated with divers kinds of crystalline (igneous ?) rocks. In Victoria and Nova Scotia these are chiefly granitic and gneissic; while in the province of Quebec, and in Britain, serpentinic, dioritic and feldspathic forms are more prevalent. As above stated, they occur as beds, dykes, veins, or masses, sometimes parallel with, but often intersecting the stratification. I am not aware that any of these crystalline rocks have ever yielded gold either in Britain or in Nova Scotia; and the instances of their having done so in Australia are not numerous; the most noted and remarkable being that of the dioritic dykes with horizontal richly auriferous quartz veins intersecting them, numbers of which were found in the gold district of Wood's Point, Victoria, traversing slates and sandstones, probably of Upper Silurian age. An accurate sectional view of one of them is given in my Notes on the Geology and Physical Geography of Victoria, Plate IV.

Dr. Genth.

In this connection Dr. F. A. Genth, of Philadelphia states, [American Journal of Science, 2nd Series, vol. xxviii, page 253, 1859.] "Gold is frequently "found in diorite (in smaller quantities in syenite and granite) and although "it is only rarely observed in the massive rocks, I have seen specimens from "Honduras, C. A., where it was imbedded in the diorite without any other "association. The result of the complete decomposition of the diorite is a "red clayish soil, and this has, in the gold region of North Carolina, etc., a "reputation for its richness in gold."

What influence the crystalline rocks, or the causes which produced them have had on the formation of the quartz veins with which the gold is generally associated, has not been in any case satisfactorily determined.

Geological age of gold.

It would appear however, apart from secondary causes in connection with the alluvions, that a general similarity in the geological conditions and associations under which the gold occurs exists in all auriferous regions, whether the veinstones are connected, as in Canada, Britain, and Australia, with eozoic and palæozoic strata; or as in California and Switzerland, with mesozoic formations; or as in Hungary and Transylvania with rocks of tertiary age; and thus the probability of the occurrence of veins bearing gold, or any

other metal or metallic ore in any particular region, can never be determined by the geological age of the rocks alone, but rather by the physical conditions and influences connected with metamorphism, upheaving, fissuring, dislocation and invasion by crystalline rocks, to which they have ineach case been subjected since their original deposition.

I have no wish to enter here on the intricate question of the age, origin, and mode of formation of metallic deposits, and mineral veins: and it is unnecessary to refer to the numberless theories which have been propounded to account for the varied phenomena which they present, except in so far as they are more immediately connected with the facts observed regarding the auriferous quartz veins of Nova Scotia, and other parts of the Dominion, or appear to have some practical reference to their probable extent and future development.

Origin of mineral veins.

It is now generally admitted that direct igneous agencies, in the sense of injection of fused matter, have played very little, if any, part in the production of mineral veins, or in the distribution of the ores found in them, and also that auriferous quartz veins present no features which would serve to distinguish them from any other class of ore-lodes, either in their origin or in their mode of occurrence; and on these grounds I have long held the opinion that there was no *à priori* reason why such veins should not contain gold in sufficient quantity to be profitably extracted at any depth to which ordinary mining operations can be carried. *

If most mineral veins and their ores are due, as I believe them to be, † to infiltration and segregation of mineral matters, chiefly through the agency of subterranean mineral-charged gases and thermal waters, penetrating and percolating under favoring conditions into and through cracks and openings which have been formed in the crust of the earth, either by seismic, plutonic or volcanic action, or through dessiccation and cooling, causing contraction and corrugation; then there appears no reason physical, chemical or geological which should determine all or the greater part of the gold in auriferous veins, towards those particular parts which now constitute their surface-outcrops, but which at some remote earlier period were certainly many hundreds of feet beneath it.

Veins in depth

In some parts of Australia, and doubtless elsewhere also, veins have been traced from their outcrops on hills considerably elevated above adjoining valleys, across these valleys, and up the opposite slopes to equal or greater elevations; portions of the outcrops in the valleys being as rich as other parts of the same vein on the summits of the hills. In such cases the valleys represent at least a great part of the denudation which the strata have suffered since the veins were formed, and if the latter are followed vertically down-

* My opinion on this point are quoted in Murchison's Siluria, 3rd Edition, 1858, pages 495, 496, 497; and 4th Edition, 1867, chap. xix, pages 464, 465, 466.

† See in this connection Dr. Hunt's remarks, Geology of Canada, 1863, page 735.

wards from the hill-tops, there seems no reason why the quartz at the bottom of such shafts should not be as rich in gold as it was at the surface, or at an equivalent depth beneath it, in the valleys: the relative level of the two positions being equal, and the scooping out of the valley an accident comparatively almost as recent as the sinking of the shafts.

Again if there were really any relative and constant proportion between depth and amount of gold, then, in all cases such as that cited, admitting even a much smaller amount of denudation of the vein than would be given by the entire depth of the valley, it ought still to be manifested by the superior richness of the hill-outcrops; but so far as I am aware, no such relation has ever been observed, and indeed no definite law of general practical application seems to be yet known as affecting the distribution of gold in veins, beyond the prevalence of that regular irregularity which is more or less characteristic of ore-deposits of all kinds, and in every region. In the Montague gold district Mr. Brown, manager of the Montague mine, states there are numbers of cross veins, some exceedingly rich, while others are totally barren. Locally, however, there are doubtless indications of various kinds, which, through long practical acquaintance with them, are valuable guides to the miner in directing his explorations; but these are not generally applicable beyond the limits of the district or country in which they have been observed. Distribution of gold in veins.

Though it is not difficult to show that the great majority of all the worked auriferous quartz-deposits are of more recent origin than the rock in which they occur, it is seldom possible to determine exactly at what subsequent period they were formed. In Nova Scotia there seems good evidence in the well-known occurence of gold in the Carboniferous conglomerates at Gay's River, that at least some of the veins are of pre-Carboniferous age; but on the other hand there is no reason why many others may not be even of tertiary date or immediately preceding the denudations by which the recent auriferous alluvions were formed. Age of Nova Scotia veins.

It is commonly supposed that when veins cease upwards at the conformable or unconformable line of contact of two formations or rock-masses, this circumstance is in itself a proof that such veins were formed during some period antecedent to the deposition of the superior and younger formation, and doubtless such is frequently the case; but it is, I conceive, by no means an axiom, and should always be applied with caution; inasmuch as it is not only possible, but even probable that conditions favorable for the formation of openings, cracks and fissures, and the introduction of minerals into them, may have affected the sediments of one formation, without operating beyond its limits, either upwards or downwards, in rocks which differed greatly in physical and mineral characters, as well as in geological age. I have elsewhere pointed out certain reasons for supposing that quartz veins differing greatly in age and in mineral contents, but hardly, if at all, distinguishable by external characters Age of Australian veins.

from each other, occur in the metamorphic and slaty Silurian rocks of the Australian gold-fields. Mr. W. P. Blake, in quoting my remarks on this subject in his elaborate and comprehensive report on the precious metals, adds: "This fact is a familiar one to American quartz-miners, not only in California, but in the Appalachian gold-fields, and it suggests the possibility of there being quartz lodes of two or more distinct periods in America as in Australia." (Reports of of the United States Commissioners to the Paris Universal Exposition, 1867. Vol. II.)

The gold-streak.

The distribution of the gold in "streaks," "pipes" or "pay-chimneys" in the quartz veins is a feature common to Nova Scotia, to Australia, and to California. These streaks are always found to have a dip more or less transverse to the dip of the vein; they sometimes vary greatly in width at different depths on the course of the vein, and are therefore more or less lenticular or wedge-shaped, not unfrequently dying out altogether before reaching the surface. In some veins they are stated to occur at no great distance apart, while in others they are separated by great thicknesses of comparatively barren quartz. Thus in following the veins downwards, if the streak happens to be narrow, it is speedily passed through, and the sudden impoverishment of the quartz causes a mine to be abandoned, when by a little furthur exploration in the direction of the dip of the streak a very different result might have been obtained. At present there is not much reliable information on this subject, thoughit is one well deserving of closer investigation. Prof. H. Y. Hind in his "Report on the Waverley Gold District," gives a number of interesting facts concerning it, and states that at Sherbrooke, in some mines the gold streak on the south side of the anticlinal dips to the east at a high angle, and on the north side to the west at about the same angle; and at Waverley, that the streak in the North lead dipped from west to east, and in the North Taylor, South Taylor and No. 6 leads, dipped from east to west. The above leads are all on the north side of the anticlinal.

As regards the mines at Sherbrooke above cited, unless the leads or layers of quartz to which the observations refer have been proved undoubtedly to be parts of the same bed on either side of the axis, very little can be deduced from the facts recorded. On the other hand, if it could be proved that such a reversal of the dip of the gold streak always occurred on the opposite sides of the anticlinal, in quartz layers which had been proved to be identical by being traced continuously round the end of the axis, then indeed we should have the strongest evidence, if not of the quartz layers having been actually deposited at the surface at the same time as the slaty and arenaceous rocks of the country, at least of their having been formed, and the gold distributed in them in bands, in the manner in which it is now found, antecedent to the operation of the forces by which the main anticlinal and synclinal forms of the strata were produced.

The theory above alluded to, of the contemporaneous origin with the enclosing strata of certain gold-bearing bands in North Carolina, is advanced by the late Professor Emmons in his report on the Geology of that State, published in 1856; and as early as 1837 Professor B. Silliman seems, from the following extract from his "Remarks on the Gold Mines of Virginia," (American Journal of Science, vol. xxxii, page 10●,) to have held a similar view regarding some of the gold-lodes of that region. He says: "the auriferous or gold-bearing quartz of the gold-region of Virginia (and as far as I am informed of the states further south), form not strictly veins, but rather beds or layers, in general not interfering with but conforming to the regular structure of the slaty rocks of the country, and like them descending to an unknown and probably an unfathomable depth. . . . . The quartz is therefore as regular a part of the structure of the country as the slaty rocks themselves, and when it is auriferous, the gold is disseminated through it in spangles, flakes and points, sometimes visible on breaking the quartz, but most usually entirely invisible even with a powerful magnifying glass. . . . . "The gold being generally disseminated in the quartz of this gold-region it is obvious that it must have been laid by in its stony bed at the same time that the quartz and the slate rocks in which it is contained were deposited." The manner in which the gold is disseminated in the quartz, cannot be considered as affording any evidence on this point, because it is as common in true veins which intersect the stratification, as it is in the bedded veins above described. **Interstratified beds.** **Emmons, Silliman.**

Dr. T. Sterry Hunt, Mr. Hind and other writers, express views respecting those auriferous quartz lodes in Nova Scotia, (which have been found to be more or less parallel with the stratification of the country, both in strike and dip,) agreeing with those of Prof B. Silliman in Virginia and Prof. Emmons in North Carolina. A similar mode of occurrence of quartz layers containing gold has been recorded in California; and I have described it as likewise occurring in Australia. Neither in Australia or in Nova Scotia, however, have I yet met with evidence which I consider of su● a nature as to prove with certainty the truth of the supposed contemporaneous origin with the slaty rocks, of such quartz layers; and I am far more inclined to agree with the remarks of Lieber, [Geological Survey of South Carolina, 1856, page 10,] where he says, "All veins are younger than the country; and hence it is without any reason that many writers regard those only as veins which dip or strike unconformably with the country-rocks, for it is evidently quite immaterial what peculiar relative position is occupied by the two as concerns the origin or the general characters of the veins. Crevices may be formed in any direction, and it is but reasonable to suppose that the planes of stratification, being possessed of less cohesion, will at least as readily present themselves for the formation of cracks or fractures, as those planes which traverse the more compact and less fragile portions of the rock." **Hunt, Hind.** **Lieber.**

The bedded quartzite or quartz rock in which the gold is found in North

and South Carolina, apparently partakes more of the character of a mechanically deposited siliceous sandstone, and the gold which is distributed in it may very possibly have been mechanically derived from pre-existing auriferous rocks. The auriferous quartz veinstone of Nova Scotia is strictly of the kind ordinarily known as vein-quartz; and on this account is not comparable to

Nova Scotia lodes.

the gold-beariug quartzite and quartz rock of North and South Carolina. Besides this there are numerous facts in connection with the gold-lodes of Nova Scotia, which are opposed to the theory of their having been formed at the surface together with the slaty rocks; and are strongly in favor of the opposite view, which I entertain in common with other observers, viz.: that all the deposits of auriferous quartz in Canada, whether they appear as "bedded lodes," "intercalated lodes," "gash-lodes" or "true lodes," have alike been formed since the deposition and consolidation of the arenaceous, slaty, crystalline or other rocks, with which they are now associated. This is I believe, equally true of the Australian gold-veins.

The classification of the lodes given above is that adopted by Mr. Hind, in his recent Report on the Sherbrooke gold-district, in which also he defines these different kinds of veins, but says: 'The origin of the intercalated lodes

Intercalated lodes.

is obscure." It appears to me to be no more so than is the origin of all lodes, and I see no sufficient reason for distinguishing the latter from the bedded lodes. Mr. Hind apparently does so chiefly on the ground of their being associated with broad bands of slate: whereas the bedded lodes usually have one wall of sandstone and the other of slate, and are associated with alternating thin bands of slate, and thick beds of the so-called whin, a grey or greenish-grey feldspathic sandstone or grit. Mr. Hind further remarks on this point: "But the conditions required for their formation appear to be in a great part satisfied if we suppose that they represent lines of minimum pressure during the folding, denudation, and faulting of the strata." This, and the reasoning respecting them on pages 24 and 25 of his Report is, I think, equally applicable to the bedded lodes; and indeed, Mr. Hind himself seems to be inclined to this view, when he says: "The same reasoning which is applicable to the formation of intercalated lodes may render it doubtful whether any bedded lode, not clearly a fissure-lode, can strictly be regarded as of contemporaneous age with the enclosing rock."

I have carefully examined the veins cited by Mr. Hind as examples of intercalated lodes at Sherbrooke, and likewise others at Isaac's Harbor and elsewhere in Nova Scotia. These belts of leads are, as Mr. Hind points out, in broad bands of slaty rock, which is often so intimately associated and interlaminated with the bands, layers and strings of quartz that the whole body of the rock, often for twenty feet in width, is taken out and milled; the gold frequently occuring in films between the slaty laminæ, as well as in the quartz and mispickel.

Similar belts occur in Australia, and are worked in a similar manner, but

they have not generally proved as permanently profitable as the better defined veins with distinct walls. This arises partly from the great difficulty, danger and cost of taking out the rock to any considerable depth over such wide spaces as twenty feet. The best mines of this description in Australia have been situated on steep slopes, or in more or less isolated hills, which offered facilities for quarrying, rather than mining the material, and for obtaining very large quantities at a very small cost.

In Australia and in Canada, I have observed that where these belts occur, the planes of cleavage and of bedding usually coincide very nearly, both in strike and dip; that the strata are nearly vertical, and afford undoubted evidences of great pressure and of motion of one plane upon another, producing fractures and openings; frequently so much is this the case as to have given rise to the term of "mullocky" reef or lead, expressive of the crushed and fractured condition of the ground. The layers of quartz in these belts are generally thin, from a mere thread to eighteen inches or two feet, but probably do not average twelve inches. They are more or less lenticular, and sometimes are clearly seen to pass obliquely from one plane to another, in such a manner as to preclude the possibility of their having been deposited contemporaneously with the slates. The principal difference between the bedded and the intercalated lodes appears to consist in the greater persistency of the latter over wide spaces, without passing out of the bed of slate in which they occur, although within its limits, (usually a thickness of some three to five feet,) they not unfrequently pass from one plane to another; and this appears to be more particularly the case where the slaty band is affected by cleavage, the planes of which are slightly transverse to both the strike and dip of the strata. It is in such situations that those curiously contorted and corrugated forms of veins are met with which, though rare and exceptional in Australia, are very common in Nova Scotia, and which may be said to culminate in the noted and often described barrel-quartz of Waverley. **Belts of veins.**

The greatest depth to which any bedded or other quartz lode has yet been followed in Nova Scotia is less than 450 feet.* What the greatest horizontal distance is through which any one vein has been traced in connected or continous underground workings, I am not aware. But it is certainly very insignificant as compared with what might reasonably be expected if they really represent beds analogous to seams of coal or iron ore in their mode of occurrence, as is implied by the theory under review. **Depth of veins.**

In order to substantiate their origin by contemporaneous deposition at the surface, it would likewise require to be explained in a more satisfactory manner than has yet been done, why they are always found in close connection with anticlinal axes, and never at the outcrops of the main synclinal folds, or

*At the Clunes mine, in Victoria, Australia, veins which strike and dip conformably with the slaty rocks are now being worked profitably at a depth of 690 feet; the yield being 12 dwts. to the ton.

associated with strata which have not been subjected either to metamorphic agencies, or to folding or faulting.

Anticlinals. This constant connection with anticlinals seems also to be characteristic of the gold-region of California, of which Dr. Hunt states, on the authority of Prof. J. D. Whitney: "These conformable lodes are generally exposed on the upturned edges of eroded anticlinals, but in one case in Nevada County a remarkable lode is mined, which is described as consisting of three distinct floors or bands, having a very flat dip, and seeming to form a kind of basin, apparently a synclinal form." Two instances have been recorded in Nova Scotia, in which the vein is represented to have been traced round the synclinal axis. I have examined these on the ground, and I find that at Isaac's Harbour the so-called synclinal is nothing more than a small undulation near the crown of the main anticlinal axis. At Lawrencetown a similar form is distinctly shewn in the section of the beds which accompanies the report of Messrs. Shelford and Robinson, 1869, on the Werner Gold Mining Property, and I have no doubt the instance of the synclinal form cited in Nevada County, California, is one of a precisely similar occurrence.

Horizon of gold-veins. It has been suggested, in order to account for the general absence of quartz layers, either in connection with the synclinal folds, or at any considerable distance removed from the main anticlinal axes, that the quartz and gold were deposited only along a certain horizon extending upwards from the lowest exposed beds of the series to within 2,640 feet, according to Campbell, of the base of the upper clay-slate group; that these lower beds, with their associated quartz layers, have been brought up by a series of anticlinal folds, and their edges exposed by denudation; whereas the corresponding beds in the synclinal folds are deeply buried, and are overlaid by the upper beds, which are not within the gold and quartz zone, and therefore on their denuded edges present no intercalated quartz bands. This seems to be a somewhat arbitrary limitation of the period during which quartz and gold were deposited, especially as we find that even in the upper black slaty series, where the strata present similar conditions, auriferous quartz layers are not wanting.

The structure of the country has not yet been worked out and mapped with sufficient accuracy however, to prove that quartz layers are limited to any particular part of the series, or that the several anticlinal folds on which the worked lodes are situated in the different districts, do not include beds which belong to all parts of the series; and if they do, then there is no reason why the out-cropping edges of the strata in the main synclinals should not be accompanied by intercalated quartz layers as commonly as are those of the main anticlinals.

Clay-slates. There is no doubt that black pyritous earthy slates, to the exclusion of thick-bedded whin or sandstone, and with a very few quartz layers, constitute a very considerable thickness of strata overlying the more richly auriferous sandstone series; but, as before noticed, quartz layers are not absent

in the former; and where anticlinal axes occur in them, as at the Ovens, profitable gold-workings have been established. Whether the beds at the Ovens, and at Indian Path, in the same neighborhood, are high up, or low down in the upper slate series has, so far as I am aware, not been determined by any reliable means.

The total thickness of the whole series is estimated by Mr. Campbell at nearly two miles, or over ten thousand feet. My observations do not enable me at present to express any opinion whatever on this point; but there seems no reason to doubt the correctness of Mr. Campbell's estimate. The general absence of organic remains, and of strata of limestone, or other well marked beds, renders it extremely difficult to identify, for the purposes of correlation, the groups of strata which are exposed in the several districts; it is, therefore, essential, in order to arrive at any sound or practically valuable conclusions, that the distribution of these groups, and the associated granitic and gneissic rocks should be traced out and accurately mapped. Without such preliminary work, the result of any attempt to parallel the rocks of one district with those of another, except in the most general way, must be entirely conjectural. The distance, in each case, from the axis to where the upper black slaty series commences, if carefully measured, might to a certain extent serve as a guide, but this has not yet been attempted; and nothing definite is at present known respecting the distribution of the several groups of strata which constitute the great auriferous series of Nova Scotia. Thickness of strata.

At first sight perhaps the solution of the question, how and when the leads were formed, may appear to be of no practical importance; but on further consideration it will be seen that it is so in two ways; first, as regards the surface-area over which the leads may probably be found; and secondly, in regard to the probable depth to which such intercalated veins or leads are likely to extend.

Mr. Hind, in his report on the Waverley Gold District, 1869, says:—"The Waverley leads are indefinitely prolonged in all directions, like the interstratified slates and whin;" and, infers that they extend in unbroken sheets from one district to another. If they are beds, such should of course be the character of their distribution, in which case their occurrence might reasonably be expected to be co-extensive with the accompanying slates and sandstones, irrespective of the attitude which the latter happen locally to present, whether horizontal, slightly inclined, or sharply folded. If on the other hand, they are of subsequent origin, and due to infiltration and segregation of mineral matter into openings which have been formed along lines of minimum pressure, while the forces were operating which resulted in the upheaval, corrugation and cleavage of the strata, then we should expect to find them developed to any considerable extent, only along and in proximity to the anticlinal axial folds; and only rarely and accidently where the strata were horizontal or very slightly inclined, or in connection with main synclinal axes, Hind on extension of lodes.

representing the lines of maximum pressure; and we might also expect the beds to diminish gradually in number, and to be less permanent in depth as wé recede from the lines of minimum pressure indicated by the main anticlinal ridges.

The facts observed appear, to a great extent, to bear out these theoretical deductions; the vein-like character of the quartz; the comparatively limited distances through which the layers have been traced; their more or less lenticular form; the evidences of motion in the enclosing rocks; the constant connection with anticlinal axes, and the absence of corresponding quartz layers through great thicknesses of strata which do not present evidences of much disturbance and corrugation, are circumstances, all of which are strongly opposed to the theory of contemporaneous deposition, and as strongly in favor of the opposite conclusion.

Anticlinals. Mr. Campbell has recognized six principal east and west anticlinals, and he groups them, according to Dr. Hunt, (Report on the Gold Region of Nova Scotia), in the following order from south to north: 1st, Ovens and Tangier; 2nd, Lawrencetown and Wine Harbour; 3rd, Old Tangier (Mooseland), and Sherbrooke; 4th, Waverley and Isaac's Harbour; 5th, Oldham and Country Harbour; 6th, Renfrew. The principle by which the above grouping of the gold-fields on the several anticlinals has been determined, is not very apparent. If the average strike of the rocks is assumed to be about N. 80° E., and S. 80° W., magnetic, it will then be seen, supposing the positions assigned to the several localities on M. Kinlay's map of Nova Scotia to be approximately correct, that the Ovens, instead of being on the southernmost or first axis, would be on the most northerly but one; and the grouping from south to north would be—1st, Wine Harbour and Isaac's Harbour; 2nd, Tangier and Sherbrooke; 3rd, Lawrencetown and Old Tangier; 4th, Waverley and Jennings's Diggings; 5th, Ovens and Oldham; 6th, Renfrew and Mount Uniacke. In the above grouping Montague would come in between Waverley and Lawrencetown, and near the parallel of Jennings's Diggings.

As regards the Ovens and Indian Path leads, they are on anticlinal folds which there affect the upper black clay-slate series, and it is exceedingly doubtful whether these can be paralleled with any of those which affect the districts on the western side of the great granitic and gneissic belt which, terminating in Mount Aspatogen and Cape Sambro, completely separates the

Strike of rocks. whole of the eastern gold-districts in the counties of Hants, Halifax and Guysborough, from those of the western counties of Lunenburgh, Queen's and Yarmouth. In the southwestern districts, from Yarmouth to Chester, the strike of the rocks ranges between S. 10° W., and S. 80° W., or within 35° of southwest and northeast. In the eastern districts it ranges from N. 75° E. to S. 55° E., magnetic; the most southeasterly dips being in the districts of Sherbrooke, Isaac's Harbour and Wine Harbour.

The nature and the probable age and origin of the great granitic and

gneissic belt above alluded to, and of other smaller but similar bands in the eastern districts, are questions of considerable interest and importance. They have been alluded to and discussed by Dawson, Hind, Campbell and other writers, and considerable diversity of opinion exists respecting them, which is not likely to be cleared up or removed by further discussion, or indeed by any method short of actual survey.

The granitic belt certainly occupies a much more prominent place in Nova Scotian geology than has hitherto been assigned to it on any published geological map of the Province; although Mr. Hind alludes to it in the introduction to his recent report "On the Sherbrooke gold-field, and on the gneisses of Nova Scotia," where he says:—"Throughout the length of Nova Scotia, from the Gut of Canso to the Tuskett Islands, there exists an interrupted axis of granitic rocks, which have hitherto been regarded as almost altogether composed of eruptive granite." And again, on page 6, he mentions that he has traced it from near Windsor to Cape Sambro, and that he believes it to extend thence to the Tuskett Islands, near Yarmouth, a distance of 135 miles in an air-line. It may properly be described as a continuous crescent-shaped band, of varying width, sweeping in a bold curve from its commencement, or eastern horn, at Cape Sambro, through the counties of Hants, King's, Annapolis, Digby, Yarmouth and Shelburne, to its termination or southwestern horn, at Cape Sable. I have examined it in all the above-named districts, and the impression I at present have, is that it is strictly of an indigenous character, and neither an old granitoid gneissic series of Laurentian age, nor an intrusive mass. Dr. Dawson has shewn (Acadian Geology, 1868), that in different parts of its course it comes successively into contact with Lower Silurian, Upper Silurian and Devonian rocks, and the manner in which these sedimentary strata are affected at the lines of contact scarcely leaves room to doubt the posterior origin of the granite; but whether as an intrusive mass, or by the metamorphism *in situ* of the stratified rocks, (in part by a process of molecular re-arrangement of their original component particles,) is perhaps uncertain. From personal observation, I have not much knowledge of the distribution and relations of the granitic and gneissic rocks in the eastern counties. They have, however, been observed at so many points from near Waverley, eastward to Cape Canseau, that it seems probable they will eventually be found to constitute a band almost as uninterrupted as they do in the western counties. But in any case they undoubtedly occupy a much more extensive area than is assigned to them on the published geological maps. **Granitic belt.**

The relations of the granite and gnessic rocks in Nova Scotia to the surrounding auriferous strata, are perfectly analogous to what is observed in this respect in the Australian gold-districts, most of which are in close proximity to similar granitic centres. In one instance an auriferous quartz vein, which had been worked close up to the boundary of a large granite area, was found to pass gradually, by the addition of feldspar and mica, into granite, **Relations of granite to gold rocks**

losing its auriferous character and becoming a vein of ordinary grey granite exactly resembling the rock of the neighboring granite mass, into which it eventually merged. It will be interesting to trace out the manner in which the quartz beds in Nova Scotia terminate in their strike towards granite masses. This could probably be most advantageously studied at Mooseland, where massive quartz veins occur only a few hundred yards distant from the granite.

Barrel-quartz. In reference to the peculiar barrel-quartz already adverted to, and which, in various modified forms, is very characteristic of numbers of leads in Nova Scotia, though it has frequently been described, no very satisfactory explanation has yet been given of the cause to which it may probably be ascribed. During the past summer I have made some observations which will perhaps help to throw a little light on this question: much careful observation, and the collection of a much greater number of facts is, however, yet required for the complete elucidation of the subject, which is one involving intricate questions of geological dynamics. The facts I have observed, however, all seem to lead to the conclusion that the corrugation of the quartz is intimately connected with, and dependant on the operation of the forces which produced the slaty cleavage; the same forces have likewise, in all probability, caused the openings between the beds in which the quartz has been deposited; and also the great parallel east and west synclinal and anticlinal foldings of the strata.

In every corrugated vein which I have examined, the axes of the corrugations or barrels always coincide with the strike of the cleavage. If the walls are of sandstone (whin), they are rarely corrugated, and seldom show, any cleavage-planes; though their surfaces, especially if in immediate contact with the quartz, frequently show ridges or parallel undulations, which strike with the cleavage and seem to have impressed corresponding swells or undulations on the quartz. Where cleavage and bedding coincide in strike and dip, no corrugations occur, nor are they observed in layers which are enclosed between walls of hard whin.

Corrugated lodes. All those veins which are sharply corrugated and contorted, lie within the limits of beds of highly cleaved soft slates of from three to five feet wide, between beds, either of whin or of whin and a hard compact slaty rock, which constitute the walls of the veins, but in no instance exhibit corrugations corresponding with those of the vein, and are commonly perfectly smooth and even throughout. Beautiful examples of such veins occur at Oldham in the Scheffer lead; in the Fish lead; and in the works at No. 1 Shaft of the Stirling Company. Also in the Free Claim at Renfrew; and in the Dominion Company's mine at Sherbrooke.

In veins of this character the distance between the corrugations, as well as their size is very irregular, producing forms resembling a number of badly shaped letters S strung together, or like the course of an exceedingly

tortuous brook in its windings through an alluvial flat. The slaty laminæ in proximity to the quartz conform more or less to the convolutions of the latter, and the beds in which the veins lie afford abundant evidence of great pressure, and of motion of one plane upon another, the surfaces being all more or less polished, striated, and slickensided.

The cleavage intersects the stratification at all angles, but is invariably at a higher inclination than the bedding. It varies in strike from about N. 10° E. to east and west, but is generally much more nearly east and west than north and south.

Some veins have a structure as if two sets of different sized corrugations crossed each other diagonally, dividing the vein into a series of rhombic or rhomboidal blocks. A cross section however shows that this structure is not due to the corrugation of a quartz layer of uniform thickness, but that the whole vein is composed of a very regular series of bulges, and that the longitudinal furrows are thinnings of the vein corresponding to the strike of the cleavage-lines in the wall-rock; and the similar, though smaller cross furrows correspond with a set of close joints which intersect the strata in directions more or less parallel to the dip of the latter. In such veins the quartz breaks out in blocks resembling in form the well-known septarian nodules or "turtle-stones" of the English Lias. Joints in lodes.

The Leary lead at Tangier shows a good example of this kind of structure. The foot-wall is of dark lead-grey slate, and has a perfectly smooth even face through the entire length of the workings, dipping S.5° E.$<$70°. Between it and the quartz there are about two and-a-half or three feet of broken, cleaved, and slickensided slate, the surfaces coated with yellow sulphuret of iron in thin films. The under surface of the vein presents a flat mammillated appearance, and is divided by joints into large rhombic blocks. The joints in the quartz correspond in strike and dip with the divisional planes in the wall-rock due to cleavage and jointing. In the hanging-wall thin strings of quartz are seen in many of the joints, and the lines of the joints are marked by more or less prominent ridges, which correspond to the furrows in the main vein, and dip on the wall or plane of bedding at angles dependent on the difference between the strike of the latter and of the other divisional planes. Through the kindness of Mr. Crossland, the resident manager of the mine, I obtained some very interesting specimens from this lead, showing the occurrence of the gold in the fractured slate, in the quartz, and in the mispickel, which occurs in large quantities both in the veins and in their slaty walls. Leary lead.

Having shown what I believe to be the probable origin and character of the bedded gold-leads of Nova Scotia, we may now consider what is likely to be the effect of these on their extent and permanence in depth. If their origin and character is as suggested, it is hardly to be expected they will follow exactly the laws which are applicable in this respect to

either true fissure-lodes, or to contemporaneous interstratified deposits. I have already alluded to this subject, (page 263), where it is stated that we might expect the leads to diminish gradually in number, and to be less permanent in depth the further they are removed from the axes of upheaval. I do not, however, think this, even if correct, is likely to affect injuriously the prospect of any of the leads now being worked.

Permanence in depth.

The depth to which mining can be successfully carried is, under any circumstances, so infinitesimally small when compared with the distances through which the forces supposed to be the cause of the vein-fissures must have operated, that there need be no apprehension of the limit of the latter, in depth, being reached at distances less than those through which we know them, (from surface evidence) to extend horizontally in directions parallel and transverse to the anticlinal axes; and as these distances are reckoned by thousands of feet, it may very safely be conjectured that there is practically no limit to the depth to which the leads may be successfully followed. At the same time the facts observed would suggest the probability that the largest, best, and most permanent veins will, as a rule, be those which are nearest to the anticlinal axes; and, likewise, that veins of this character are not likely to occur either in synclinal outcrops, or where there are great thicknesses of strata nearly horizontal or uniformly inclined in one direction. But in such situations true fissure-veins and cross-lodes, either in dislocations or in shrinkage-cracks may be abundant, and of such a character as to be capable of being mined with profit. These are matters which can, however, only be determined by extended and careful exploration, and are alluded to only to show that however true the foregoing conclusions may be, they are not intended, and should not be permitted to discourage "prospecting" and intelligent exploration in all parts of the auriferous region.

Extent of gold rock.

The extent of the Atlantic coast series, of stratified gold-bearing slate and quartzite has been variously estimated at from 5,000 to 7,000 square miles. My observations during the past summer induce me to think that this estimate is very considerably too large. The mistake has probably arisen from defective information respecting the area occupied by the granitic rocks; which, as I have already pointed out, is very largely in excess of that assigned to it on published geological maps, from which the computations referred to have probably been made. The area represented on Sir W. E. Logan's large map of Canada as occupied by strata of Lower Silurian age on the Atlantic sea-board of Nova Scotia is about 5,400 square miles, and of this probably fully more than 1,400 square miles are occupied by granitoid rocks. Exclusive of Cape Breton Island, 3,500 square miles would, therefore, probably represent the total extent of the area over which the stratified slaty and quartzose auriferous rocks are distributed.

The geological position and the age of these rocks has been fully discussed by Dr. Dawson † and by other of the authors whose observations I have alluded to, and all are agreed that they probably belong to the Lower Silurian period. Certain portions of them Mr. Hind has recently assigned to an older date; the possibility of which had already previously been suggested by Dr. Dawson, Acadian Geology, 2nd Edition, page 620. Geological age. Dawson and Hind.

My first impression of them, formed after personal examination last summer, and based on mineralogical and stratigraphical considerations only, was that they represented the groups known in Britain as the Harlech grit or quartzite, and the Lingula-flag series; the former mapped as Cambrian by the British Survey, and the latter as the lowest member of the Silurian system. Cambrian and Lowest Silurian.

In confirmation of this view I subsequently detected in the grey sandy and flaggy pyritous slates at the Oven's Bluffs, in Lunenburgh County numerous specimens of the genus *Eophyton*, regarded by Mr. Billings as characteristic of the Primordial Silurian epoch. This genus is common in the sandy dark slates of the city of St. John, New Brunswick; in rocks hitherto referred to the Quebec group, on the Island of Orleans; and in Newfoundland. In all these localities it is accompanied by other well marked Primordial Silurian forms, which further diligent search will doubtless also disclose in Nova Scotia. Fossils, Eophyton.

Mr. Billings has supplied the following remarks on these fossils;— Mr. Billings.

"The fossils discovered at the Oven's Bluffs are generically if not specifically identical with those described by the Swedish geologists, Torrel and Linarsson, under the name of *Eophyton Linnæarum*. They suppose them to be plants, but as none of the specimens exhibit any internal structure, this view does not meet with general acceptation, and the theory that they are trails or tracks of marine animals seems to find more favour. Upon the question of their true nature I do not at present venture to give an opinion; whatever they may be, they seem to be confined to the lower portion of the Silurian system. Distribution of Eophyton.

"The following is the geological position of the genus *Eophyton* in other countries, so far as it is yet known:—

"1. In Sweden, where the *Eophyton* was first discovered, it occurs in the rock long known as the Fucoidal sandstone, which immediately underlies the alum-slate; this latter formation is undoubtedly the representative of the Lingula flags of Wales. Sweden.

"2. In Newfoundland it was discovered in 1867, by Mr. Murray, on Great Bell Island, Conception Bay. It is there associated with two new species of *Lingula*, a *Cruziana* closely allied if not identical with *C. semiplicata*, (a Lingula-flag species) and several fucoidal forms. Mr. Murray considers the rocks of Bell Island in which these fossils occur to lie above the beds holding Newfoundland

† Acadian Geology, 2nd Edition, pages 613 and 614.

Paradoxides, and they would thus probably represent the upper portion of the Lingula-flags.

New Brunswick.

"3. It occurs at Milkish Passage, near St. John, New Brunswick, and also in the city of St. John, in sandy shales. At the Milkish Passage the beds are said to be older than the trilobite beds of Drury's Cove; these latter are the Lower Lingula-flags.

Orleans Island

"4. On the south side of the Island of Orleans, near the village of St. Laurent, *Eophyton* was found last spring by Mr. Weston. It is these associated with several species of fucoids identical with those that occur on Great Bell Island. The rocks here are referred to the Quebec group, but as they are considerably disturbed, it is not impossible that they may be older and brought up by a fault. There is a small lenticular mass of limestone in these rocks in which Sir W. E. Logan and I found, several years ago, three species of trilobites which I have always considered to be of a more ancient type than any known to me in the Quebec group. These fossils occured in pebbles of limestone imbedded in the calcareous rock which constitutes the lenticular mass itself.*

"5. In the Geological Magazine, vol. 6, (1869,) a fossil is described by Mr. Hicks, from the Lower Arenig rocks of St. David's, under the name of *Eophyton? explanatum*. Mr. Hicks considers it to be distinct specifically from the Lingula-flag form, and even refers it doubtfully to the genus.

"So far as my own experience goes during the twenty-five years that I have collected fossils in the Lower Silurian, from the Potsdam upwards, I have never seen a fragment of any thing that could be referred to *Eophyton*. Neither has any ever been described or figured by any author as occurring in beds above the Lingula flags, with the exception of the doubtful form by Mr. Hicks, above mentioned. If it be true, therefore, that *Eophyton* is merely a track, I am inclined to the opinion that the animal that made it belonged to a very ancient genus, which appeared during the earliest Primordial Silurian period, attained its greatest development during the era of the Lingula flags, and died out at the close of that era. It is a remarkable fossil, and wherever found, it occurs abundantly, and it is therefore almost impossible that if the animal lived on through the Silurian period its traces could have so long escaped the notice of the great number of workers in Silurian geology."

Horizon of Eophyton.

Hitherto, except the very doubtful and obscure forms detected by Mr. Hind in the quartzite at Waverley, and referred by him to the genus *Palæotrochis*, but in which Mr. Billings states that no distinctly organic structure can be discerned, no organic remains whatever had been detected in the Nova Scotian gold-bearing rocks, and therefore their geological position remained uncertain.

* This fact would indicate that the age of these rocks is younger than that of the imbedded fossils. A. R. C. S.

In general aspect, and in the succession of the beds the whole series in Nova Scotia closely resembles the Cambrian and Lingula-flag series of North Wales, which is likewise characterized by holding auriferous quartz veins, The lower members of the series (Cambrian) there consist of a succession of thick bedded greenish-grey feldspathic grits and sandstones or quartzites, with intercalated slaty bands; and these are conformably overlaid, as the similar beds are in Nova Scotia, by a set of black earthy and pyritous slates and sandy beds (the Lingula-flags) with quartzose mineral lodes. Numerous associated diorite dykes are likewise characteristic of the series in both regions. Thus mineralogical characters, physical aspect and palæontogical evidence all combine to prove the above view to be correct regarding the age of the Atlantic-coast series of Nova Scotia. **Cambrian of Wales.** **Lingula-flags.**

I have seen no evidence in the eastern gold-districts of the existence of any formations which are certainly older than the lowest members of the quartzite group, although doubtless such are quite likely to occur without their having been observed by me in the very cursory examination which it was possible to make during a part of only one season over so large a tract of country. On the southwestern coast, between St. Mary's Bay and Tuskett, there is a set of rocks exposed which, especially in the immediate vicinity of Yarmouth, differ greatly in aspect, and generally in their mineralogical characters, from any met with in the eastern auriferous series. They are probably of a different age; but to what group they belong is at present uncertain. At Yarmouth, between Yarmouth and the Chegoggin River, and on Cape Fourchu Island the strata are well exposed. I did not visit Chegoggin Point; but at Cranberry Head, the next point to the northward, where the only gold-mine in this district is situated, we find, associated with the vein, soft grey and olive-green fissile slates, and also bands of whitey-brown micaceous sandstone. On the shore immediately underlying the beds in which the vein occurs, there are thick-bedded hard grey and whitey-brown feldspathic sandstones, with scales of silvery white mica. Associated with the sandstones are bands, from six inches to two feet thick, of blue and greenish-grey slate. These continue for about three quarters of a mile along the shore, nearly with the strike, when a massive diorite dyke cuts the beds nearly at right angles, without disturbing them beyond causing a slight curve in the strike. The dyke is 150 yards wide, and is succeeded by similar sandstones and finely cleaved slates for a quarter of a mile further. Some of the sandstones enclose pebbles of a grey quartzite. At the mine the beds dip S. 55° E. $<$ 60°; and at the end of the section about one mile to the north, S. 60° E. $<$ 60°. From the mine southward, there is a gradually ascending section, consisting of grey slates, olive-green slates, and grey sandy, and blue and black papery crumpled slates. The highest beds in the section are the fine black earthy pyritous slates. The **Older rocks.** **Yarmouth.**

dip continues S. 60° E., but the angle gradually increases from 60° at the mine to 85°, and becomes vertical at the southernmost end of the exposure.

Cape Fourchu.

The rocks at Cape Fourchu Island, and thence to Yarmouth, consist of hornblendic, chloritic, epidotic, and micaceous strata, with dark greenish and black slates; also massive crystalline epidotic diorites, with large enclosed patches of epidote rock. Near the extreme west point of the island, there is a thick bed of coarse conglomerate, on the weathered and sea-worn surfaces of which the pebbles are well seen; while in a fresh fracture they can with difficulty be distinguished from the matrix, (which is a greenish-grey micaceous schist,) except by a slight difference in color. The pebbles are all flattened and more or less elongated in the direction of the cleavage-planes. They consist chiefly of a grey fine grained micaceous gneissic rock; some are of a brown-weathering feldspathic sandstone, and others of an epidotic rock similar to the immediately adjoining strata. The schistose beds occasionally contain crystalline grains of magnetic and of titaniferous iron ores, and epidote is often very abundant in them. This, from the weathering of the softer matrix, is left projecting in small lumps and irregular ridges over the exposed surfaces, giving these a singularly fretted and rough appearance. Veins and large lenticular masses of vitreous white quartz are not uncommonly associated with the more slaty beds. One very prominent mass of this kind is known as the Canoe. It lies in a joint nearly at right angles to the stratification, on the west shore of the island, and from a little distance, especially seaward, has the appearance of a large canoe stranded on the rocks. In the eastern part of Yarmouth, within the town-limits, there are some thick beds of massive grey or whitish-brown quartz rock, (with large irregular reticulating veins of white quartz,) interstratified with the green chloritic, hornblendic and epidotic schists. On the road between Milton and Arcadia (Church's map) similar chloritic and hornblendic beds occur, and also some bluish-grey feldspar-porphyries or felsites.

Diorites, chloritic and epidotic rocks.

Iron ores and epidote.

Jebogue Point

At Jebogue Point there are several quartz veins from six inches to three feet thick, associated with black crumpled slates, and the rocks exposed are similar to those at Cranberry Head. Samples from one of the most promising looking of the above veins have been assayed by Dr. Hunt, but afforded no trace of gold, though containing a good deal of arsenical sulphuret of iron. It is reported in the neighbourhood that gold has been found in some of these veins, but no attempts have been made to work them.

To the north, at Cape Cove in the county of Digby, a few chains east of Cape St. Mary lighthouse, there is a small exposure of green chloritic rocks, like those at Yarmouth, associated with light grey quartz-rock, brecciated white, brown, and silicious schist, and black earthy pyritous slates. The green schists here contain imbedded white calc-spar in considerable quantity. Their dip is S. 55° E. $<$ 80°,—84°. In specimens of these green schists, and likewise of those from Yarmouth, Dr. Hunt has found

traces of chromuim. He remarks that in their general mineralogical characters, as well as in the presence of chromium, these rocks resemble the crystalline schists of the altered Quebec group of the Canadian Survey, and also similar schists referred to the Huronian series around Lakes Huron and Superior. In other respects the rocks of Digby and Yarmouth counties, above described, are not unlike the hornblendic, epidotic, chloritic and other strata of certain divisions of the Quebec group, which, in connection with the facts above noticed, suggests the possibility that the former may occupy the position of the Quebec group. If so, we may hope to find a gradually ascending series in Nova Scotia from the Primordial Silurian slates at the Ovens in Lunenburgh County, northwestward to the Upper Silurian and Devonian rocks of the northern parts of the counties of Annapolis and Digby, perhaps interrupted to some extent by the great central granitic band. Chromium.

As regards alluvial gold-deposits, and the prospects in Nova Scotia of what is known in California as "placer" mining, I cannot do better than recommend the perusal of Mr. Hind's remarks in paragraph 6 of the prefatory* letter addressed to the Hon. Robert Robertson, Commissioner of Mines, which accompanies his recent report on the Gold District of Sherbrooke. I fully concur in all the observations and suggestions made by Mr. Hind in this letter, and anything I can say respecting it, must be more or less a repetition of what has already been pointed out by him. Alluvial gold.

In comparing the physical features of the Australian gold-districts with those of Nova Scotia, in their bearing on the question of the occurrence of alluvial gold, the principal difference appears to be the prevalence in the latter of long narrow lakes, pools and swamps in place of the similarly shaped dry grassy "flats" and flat-bottomed "gulleys," (often almost as level as lakes,) which characterize the Australian districts, and in which the rich "runs," "leads" or "gutters" of alluvial gold are found by sinking through the alluvions to the bed-rock, which generally protrudes in ledges along the margins of the flats and in the adjoining hills. If we assume the lakes and swamps in Nova Scotia to represent the flats and gulleys in Australia, there are no apparently important differences in the geological conditions presented in the two regions. It becomes a question, therefore, whether rich deposits may not underlie many of the lakes and swamps of Nova Scotia, as they do the flats and gulleys of Australia; and if so whether they could be profitably mined. To do so it might be necessary to drain the surface-water, but this would depend entirely on the depth beneath the lake-bed of the old channel or gutter. Australia and Nova Scotia compared.

At Tangier, works were commenced, as described by Professor Silliman in his Report published in 1864, See Dr. Hunt's Report on the Gold Region of Nova Scotia, page 40,] to drain Copper Lake, in order to explore Tangier.

the deposits in its bed; but the enterprise appears to have been abandoned before any result had been arrived at, and nothing was being done at the time of my visit to the locality last summer.

Nova Scotia. The reason which has been given, and apparently very generally believed, why no considerable quantity of alluvial gold is likely to be found in Nova Scotia, viz.: that over the greater part of the country the superficial accumulations of gravel have been removed by comparatively recent denuding agencies, has certainly no foundation in fact; and I can confidently assert that bare rock-surfaces are not more prevalent in the gold-districts of Nova Scotia than they are in similar districts in Australia.

It is incredible that in the latter country the gold-bearing veins should be invariably accompanied by rich alluvial deposits, while in Nova Scotia the detrital deposits, which certainly occur under precisely similar conditions, should be almost as invariably unproductive. I do not believe in any such anomaly, but think that the whole secret of the matter lies in the fact that, owing to obvious local circumstances, they have never yet been sought for with that degree of enterprise, intelligence and perseverance, which the investigation demands.

It is stated that surface-leads have occasionally been found, and have been followed for limited distances into gradually deepening ground, with highly promising indications, when the influx of water being too great to be overcome by manual labor with an ordinary bucket and windlass, the ground was at once abandoned. Under such circumstances it is not surprising that no alluvial leads have been developed in Nova Scotia.

At Tangier, at Oldham, at Sherbrooke, at Waverley, and at Renfrew, I observed places that appeared to present all the conditions required for the occurrence of rich alluvial "diggings;" but, so far as I could learn, no attempts had been made to test them, although they lie in close proximity to quartz veins which have afforded large returns, and the abrasion of which in past times must have contributed to form the detritus in the adjacent depressions.

Working alluvions. The great quantity of water which would probably be encountered in all the deep and low-lying drift-deposits in Nova Scotia doubtless constitutes a serious hindrance to their being explored, inasmuch as it almost precludes the success of individual effort, to which, in Australia, the original discovery of nearly all the principal gold-fields is due. They offer however, I consider, a legitimate and exceedingly promising field for combined capital and labor skilfully applied, and it is certainly remarkable that so little attention has hitherto been bestowed upon them.

Mr. Michel. As will be seen in Dr. Hunt's Report (page 14), Mr. Michel insisted strongly upon the importance of searching for alluvial gold beneath the glacial drift or boulder-clay of the coast; where, as Dr. Hunt remarked, the gold alluvions "may reasonably be expected to be of great richness."

Wherever valleys filled with detritus are found crossing the strike of the veins, as is the case at Waverly, at Oldham, and doubtless in many other places, explorations should be made immediately below such lines of intersection, as being the most likely to afford satisfactory results. In the few places where alluvial gold has been detected, the discovery has been purely accidental. The search has never been conducted on any defined system or principle, and was, therefore, not likely to effect more than it has done; viz: prove the presence of particles of gold in almost all the superficial sands and gravels which have been examined, and occasionally to such an extent as to be capable of being profitably extracted.

Hydraulic method.

I have not seen any localities in Nova Scotia where the hydraulic methods of washing in use in California and Australia could be successfully adopted, because the recent gravels appear for the most part to lie in depressions which are below the present drainage level of the country; and seldom on hills, or in elevated terraces along the sides of the valleys. I am not aware whether this is also the case in New Brunswick. In the province of Quebec, on the Chaudière and its tributaries, the drift appears in some cases to rest at considerable elevations above the main water-channels, and this was long since pointed out by Sir W. E. Logan. Nothing, however, has ever been done to test the value of the gravels. Recently, through the enterprise of the manager of the Company already mentioned as being the only one at present operating in that district, it has been proved that they likewise extend to depths of one hundred feet beneath them. It is in these old deep channels and depressions that the heaviest particles of gold may be looked for, and with the requisite appliances for draining the ground there seems every reason for hoping that a very extended and valuable field for gold-mining enterprise will be opened up in the province of Quebec, especially when considered in connection with the known wide distribution of gold in the region, which has been abundantly proved by the researches of Sir W. E. Logan, the details of which are given in a pamphlet entitled Notes on the Gold of Eastern Canada, issued in 1864 by the Geological Survey. This contains a summary of all the information on the subject up to that date; and in the report of Mr. A. Michel, addressed to Sir W. E. Logan, and published in the Geology of Canada, in 1866, further and more recent information has been given.

Chaudière, Quebec.

Mr. Lockwood's workings.

On the 14th February last, Mr. Lockwood informed me that in their shaft then sinking the bed-rock had been struck at 100 feet below the level of the Gilbert River, dipping three feet in the width of the shaft. This indicates still deeper ground, as does also the character of the gold met with, of which he states "We took out nearly one ounce of gold yesterday, and six pennyweights, thirteen grains to-day. It is all fine scaly gold and, I fancy, all from the gravel. We have fonnd "colors" since first striking

it, about twenty-eight feet." This must be considered an exceedingly satisfactory commencement, and quite sufficient to warrant further exertion.

The worn and comparatively heavy character of much of the gold which has hitherto been procured from the shallow washings in the Chaudiere district, does not, I think indicate that it has been derived from distant sources, so much as that it has been subjected to repeated and long continued abrasion in the drifts. I believe it to be strictly of local origin, and to have come from the quartz veins in the neighbourhood. The chief reason why the rich spots where it has hitherto been worked are so limited in extent is that they represent the places where the old channel or river-bed has been intersected by the existing one, and cut into, down to the bed-rock; re-distributing its contents along the present river-course, and thus enriching, for a limited distance, the recent alluvions. If instead of extending explorations, as has commonly been done, solely in the direction and along the course of the present river, they are pushed boldly into every part of the adjacent banks where no rocky ledges are seen in place, there is but little doubt that the old channels from which the present streams have derived most of their gold, would speedily be discovered, and often richly reward the enterprise of the explorer. These are facts which are well known in Australia, and acted upon frequently with the most successful results. Here no one appears to have directed attention to them, and they have not been alluded to in any published descriptions of the gold-fields of this country.

Ancient channels.

Mr. Lockwood states in his report to the Directors of the Company, dated 4th August, 1870:—" During the last five years I have observed closely all the work done, and have not seen one intelligent attempt made to obtain a knowledge of the nature and origin of the rich alluvial deposits; nó man except myself has done anything to establish the fact that the alluvions have their origin in the local reefs, or that we have a distinct system of old river-channels at a considerably lower level than the present ones."

" On lot fifteen the lead leaves the present river-channel and strikes under the high ground; here an old river-channel was discovered; it is from thirty-five to fifty feet below the present river-bed. A drive has been run across this channel 250 feet. The water being heavy, and the ground dipping, we were unable to determine its width. The whole of the gravel found in this channel is auriferous, and it is composed entirely of the material from the local rocks In the sand of the roof drift-wood was found about eighty-five feet below the present surface."

From the returns already obtained, Mr. Lockwood estimates the average yield per acre of the old channel at $15,000, and the cost of working at $12,500 per acre. It is, however, next to impossible to make an estimate of this kind, which shall be at all reliable for practical purposes.

The quartz veins of this district have already been examined and reported

on, and their auriferous character has been established.* I examined the outcrops of several of those from which samples were taken by Mr. Michel and carefully assayed by Dr. Hunt. No efforts appear to have been made since the date of the reports above referred to, for their further development. The result of Dr. Hunt's assays was certainly not very encouraging, but when compared with other assays made by Dr. Hayes of Boston, they only serve, as he remarks, to prove the "irregularity with which the gold is distributed in the gangue." Chaudière, quartz veins.

Some of the veins are well situated for working, and so far as can be judged from the very limited extent to which any of them have yet been opened there would be no difficulty in raising very large quantities of quartz. Considering the heavy and often nuggety character of much of the alluvial gold of the Chaudière district, it is in the highest degree improbable that none of the veins from the abraded portions of which this gold has without doubt been derived, should be sufficiently rich to yield a fair profit to well directed enterprise applied to their exploitation, and it seems extraordinary that so little has hitherto been done in this direction.

The system on which mining and mining business is conducted in Nova Scotia, like all other subjects connected with the gold-fields, has been commented on in numerous publications. Its many defects have been repeatedly pointed out, and much sound advice and a number of practical suggestions for its amendment have from time to time been offered, without however, having produced any very marked effect; notwithstanding that the success of a very large majority of the mining enterprises in the province is unquestionably in a great degree dependent on these remedial measures being adopted; and their total neglect is as undoubtedly the chief cause of the numerous failures which mark the history of the gold-fields. Gold mining in Nova Scotia

Among the causes which may be considered as most prejudicial to the permanent and healthy progress of mining industry, the following may be mentioned:—They are not in any way especially characteristic of Nova Scotia, but prevail more or less in every mining region of which I have any knowledge, particularly in the early years of their development. Causes of failure.

1st. The rash expenditure of capital in the purchase of mining-rights respecting the actual value of which nothing is known with certainty.

2nd. The hasty and inconsiderate erection of costly machinery for mining and treating the ores, before their quantity or their probable value has been determined.

3rd. The attempts frequently made to enhance the value of the stock by declaring dividends, sometimes paid out of capital, but often by means of a process commonly known as "picking the eyes out of the mine," or in other words selecting all the rich material to secure a few high yields which are far in excess of anything likely to be the future average.

* Reports of Mr. A. Michel and Dr. T. Sterry Hunt addressed to Sir W. E. Logan; in the Report of Progress, Geological Survey of Canada, 1866, pages 69-90.

4th. The too common, almost universal practice of devoting the whole of the net proceeds to the payment of dividends, and having no reserve-fund to meet expenses when poor ground has to be worked through. This improvidence frequently necessitates the closing of a mine, and the abandonment of a property as worthless, which, under a more judicious system, would have become extremely valuable.

5th. The small size of the "areas" or claims, not as regards actual acreage, but in relation to the position and thickness of the veins. This necessitates a wasteful multiplication of shafts and plants of machinery for crushing and dressing the ores. In some districts in Nova Scotia these are out of all proportion to the actual requirements.

6th. The disregard of the natural features of the ground, shewn in locating the crushing and dressing-machinery without reference to the easy delivery of the material from the mine and the fall required for the perfect treatment of the ores, and for getting rid of the tailings. This want of foresight necessitates subsequent heavy outlay for re-handling the material, all of which might be saved.

7th. The almost universal want of any appliances for saving pyrites and fine gold.

Waste of gold in tailings.

On this point Mr. Hind remarks in his recent Report on the Sherbrooke district :—"From careful assays of numerous parcels of tailings in Nova Scotia as they came from the mill, and selected indiscriminately, the average quantity contained was found to exceed 4 dwts. per ton. In many instances the assay gave a very much larger yield. These tailings lie around the mill in every direction, or are allowed to run into the nearest stream; in no instance known to me are they concentrated even to save the pyrites, or are any really valuable appliances used to save the free gold they contain, which has escaped from the stamping-boxes or the amalgamating-tables.

"A year ago, attention having been called to the escaped gold in the tailings of one of the mills at Waverley, portions were re-crushed and passed over amalgamating-tables; and in the official return for 1869, we find the following statements :—288 tons of waste from the dump, gave 32 oz. 5 dwts. 11 grs.; 63 tons of waste from the dump, gave 13 oz. 12 dwts. 16 grs. From this experiment some idea may be formed of the amount of gold allowed to escape in the tailings from upwards of 190,000 tons of quartz, the quantity already crushed in Nova Scotia."

As indicating further the probable value of some of these heaps of tailings the following analyses by Dr. Hunt, are here given of three samples which I collected from Yarmouth, Montague and Renfrew respectively. He says "the proportion of arsenical pyrites or mispickel (other sulphurets being rare), was determined by dissolving it out from the quartz; and the following figures give, under A, the amount of gold per ton of tailings; under B. the amount of gold per ton of pyrites; and under C, the proportion of pyrites in the

Hunt, assay of tailings

tailings: The determinations under A and B, were made by the ordinary fire-assay upon the roasted tailings."

	A	B	C
Montague	$5\frac{1}{4}$oz.	$12\frac{4}{20}$oz.	43 per cent.
Renfrew	$2\frac{1}{2}$	4	64 ,,
Yarmouth	$5\frac{1}{2}$	$7\frac{15}{20}$	65 ,,

The sample from Montague was taken at about eighty feet from the last amalgamating-plate, and at about seven or eight inches below the surface of the heap.

The sample from Renfrew was taken from six inches below the surface of the heap, and at about ten or fifteen yards from the last amalgamating-plate.

The sample from Yarmouth was given to me by the owner of the mill; I have no knowledge of the circumstances under which it was collected.

A sample of tailings from Mooseland, taken from the fourth mercury-trap, Dr. Hunt found to contain 58 per cent. of arsenical pyrites. A portion concentrated to 88 per cent., gave one and one-half ounces of gold to the ton: equal to 1 oz. 14 dwts. to the ton of pure pyrites.

In digging into the surface of the heaps of tailings, I noticed that the pyrites was not equally distributed through the mass, but almost always in layers, giving a regularly stratified appearance to a vertical section of the sand; the pyritous layers being from one-eighth to one inch in thickness, and the more sandy layers considerably thicker. The samples were taken rather, to show the value of the pyrites, than the quantity of pyrites or gold in the tailings; and therefore the figures under A and C are not a correct average of the heaps; but even supposing the tailings to contain no more than one half the above amounts, the value of the gold which is being annually lost is enormous, and the subject is well worthy the serious consideration of every mine-owner in the country. This fact of the richness in gold of the arsenical pyrites of the lodes in Nova Scotia is not new. Prof. Silliman, in his Report on the Tangier district, in 1864, found the pyrites extracted by washing from the tailings of three lodes at Tangier to yield respectively \$93, \$125, and \$180 of gold to the ton; while a mass of the pyrites, of several pounds weight, from Montague, according to the same authority, yielded at the rate of \$276 of gold to the ton, of which about two-thirds only were coarse gold. These facts are cited by Dr. Hunt in his Report already referred to (page 20), and he there adds,—"Notwithstanding these results, the tailings are generally entirely neglected in the Nova Scotia mines, and with them no doubt large quantities of gold are lost which might be advantageously extracted by concentration and roasting, followed by amalgamation, either in the Chilian mill, the Wheeler, or Hepburn pan, or perhaps, better still, by the use of Plattner's process, in which the gold is dissolved out of the roasted

Silliman on arsenical pyrites.

Hunt.

Roasting arsenical ores;

ore by chlorine. Prof. Silliman has suggested that the arsenic may be profitably extracted from the arsenical pyrites by roasting in properly constructed furnaces. By this means it might be made to yield half its weight of white arsenic, which has a considerable commercial value, and would probably pay the expense of roasting the ore. By thus condensing the arsenic, the injurious effects which would otherwise result from the escape of the poisonous arsenical vapours into the air during roasting would be prevented."

Working of stamp-mills.

Reverting to the wasteful multiplication of plants of machinery in the various districts of Nova Scotia, above alluded to, this will perhaps be best appreciated by a comparison of the number of stamps, and the quantity of quartz crushed in Nova Scotia with similar work in Australia. According to the tables in the Report for 1869, by the Commissioners of Mines in Nova Scotia, the total quantity of quartz crushed that year in all the districts was 38,424 tons. The number of mills employed was fifty-four. The number of stamps is not given; but if we allow an average of twelve for each mill (which is probably an under-estimate),† we have 648 stamps. They weigh generally from 550 to 600 lbs. each, and are worked at an average speed of 69 to 70 blows per minute, with a nine-inch lift.

The quantity crushed per stamp-head in twenty-four hours is stated to be one ton; the average in Australia and California is from one and one-quarter to two tons; there seems no good reason why it should not be as large in Nova Scotia. However, taking it at one ton, and allowing 250 working-days, the 648 stamps ought to crush 162,000 tons, or more than four times the work actually done, which amounts to less than sixty tons per stamp-head per annum.

Victoria, Australia.

At the Port Philip Company's mine, at Clunes, in Australia, there were crushed, in 1870, in fifty-two weeks, 55,240 tons: and in the same time in 1869, 64,273 tons. This work is performed by eighty stamps; (twenty-four of 800 lbs., and fifty-six of 600 lbs. each;) worked at a speed of seventy-five blows per minute; and they each crush from two to two and a quarter tons per day of twenty-four hours. The quartz is as hard as any I have seen in Nova Scotia.

At the Black Hill mine, at Ballarat, which commenced working in January, 1862, 250,575 tons of quartz had been crushed up to December 31st, 1869; being an annual average of 31,321 tons. This is done by sixty stamps, of 700 lbs. each, worked at a speed of seventy-five blows per minute, with a lift of about nine inches.

Thus, in Australia, we find two mills with 140 stamps, crushing 86,561

† In sixteen mills, of which particulars are given in an Appendix to "Heatherington's Guide," there are 199 stamps.

tons of quartz in the year; or considerably more than twice as much as is crushed in Nova Scotia, in fifty-four mills, with more than four times the number of stamps. The fineness to which the quartz is reduced is about the same as in Nova Scotia.

If we compare the average yield of the quartz in Nova Scotia with that in Australia, both of which are given in Heatherington's "Practical Guide to the Gold-Fields of Nova Scotia," we find the former is 1 oz. 3 dwts. 5·8 grs.,* and the latter only 11 dwt. 17·4 grs.† If we also consider the relative prices of mining-labor in the two countries, (averaging in Victoria \$2.00 to \$3.50, and in Nova Scotia only \$1.25 to \$1.50, per diem,) the reason why two-thirds of the crushing-power in the latter is standing idle seems at first sight somewhat inexplicable. It is evidently not the poverty of the quartz; neither is it, as I can vouch from personal observation, owing to any deficiency in the quantity which the veins, if properly worked, are calculated to produce; and we are therefore forced to conclude that it arises from the causes above enumerated, and from the unskilful, wasteful, and improvident manner in which the business has ordinarily been conducted, creating general apathy, and utterly destroying the confidence of investors.

Comparative yield of gold.

Price of labor.

In the two mines in Australia above cited, the average yield of gold to the ton of rock, of late years, has never exceeded 10 dwts. At the Black Hill mine it is stated to have been only 2 dwts. $21\frac{31}{100}$ grs. per ton; but even this low yield has proved sufficient to pay the proprietors ten per cent. on the capital invested; the amount paid in dividends in eight years being £21,730 sterling, or \$108,650. At Clunes, the average yield in 1869 was 7 dwts. 8 grs., and in 1670, 4 dwts. $20\frac{3}{4}$ grs. Many more instances could be given of yields far less per ton than the quantity now lost at every mill in Nova Scotia, having sufficed, under careful management, to give a fair profit to the adventurers. These results are due to the practical and intelligent application of the lessons taught by experience; and if this experience is utilized, and as intelligently applied in Canada as it has been in Australia, there is no reason why equally satisfactory results should not be achieved.

Victoria.

Profits of mining.

The want of any even approximately correct topographical maps of the gold districts is likewise a serious hindrance to their development. It renders accurate geological observations impossible; and thus the structure of the country cannot be worked out or understood, as it must be before either the probable course, or the extent of the mineral-veins can be ascertained with precision, or the localities determined in which farther developments may be looked for.

In conclusion, I may state, that the general impression produced on my mind by what I have seen of the gold-districts of Canada during the past

Conclusions

* This yield for Nova Scotia is considerably greater than tha which is given as the average by Mr. Hind, page 57 of his Report on the Sherbrooke District, viz., 15 dwts. 16 grs.

summer is, as regards their natural capabilities, exceedingly favorable, and equally unfavorable as regards the enterprise and intelligence which has hitherto been devoted to their development. At the same time it should not be forgotten that the most favorable indications are not always reliable, and the sanguine prognostications they so frequently give rise to are often not borne out by the result of actual working; wherefore I should, even under the most favorable circumstances, not advise any one to invest in such enterprises to an amount beyond what he can afford to lose without serious embarrassment.

Want of maps

The need above alluded to, of good topographical maps, is one which cannot be too often pointed out, and is well deserving the serious consideration of the Government. Such maps are not only necessary for geological and mineralogical purposes, but for agricultural, sylvicultural, engineering, military, political, and statistical purposes they are likewise indispensable; and every dollar expended towards their production eventually becomes an annual saving to the country; a fact especially obvious when such periodically recurring works as the census have to be undertaken. The subject is dwelt upon here because it is one which seriously retards the progress of the geological explorations with which I am specially charged; and it seems not out of place to call attention to the fact that hundreds of dollars which are debited to these investigations are really unavoidably expended in making additions to the topography of the country, for which, however valuable, extensive, and important, but little credit accrues to the Geological Survey.

ALFRED R. C. SELWYN.

MONTREAL, May, 1871.

REPORT

ON THE

COUNTRY NORTH OF LAKE ST. JOHN,

BY

MR. JAMES RICHARDSON,

ADDRESSED TO

A. R. C. SELWYN, Esq., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, MAY, 1871.

SIR,—In the month of April last I received your instructions to make an examination of the unexplored country to the northward from Lake St. John, on the Saguenay, with a view to ascertain the geological structure of that region, as well as its adaptability for agricultural purposes. Accordingly, I left Montreal on the 6th of June, in company with yourself and my assistant, Mr. Leitch, arriving at Lake St. John on the 13th. Here a few days were spent in examining some points not previously investigated in regard to the rocks of the neighbourhood, and in making the final arrangements for the season's work. Departure.

I may here state that I was under great obligations to Mr. Price, Senator. for having my outfit and provisions carefully forwarded from Quebec to Chicoutimi, and also to Mr. N. Flanagan of the Hudson's Bay Company, for having them sent on from the latter place to Blue Point on Lake St. John.

Having, with the assistance of the Hudson's Bay Company's officers, Mr. S. Ross and his son, procured men and canoes, our arrangements were completed on the 23rd of June, and on that day I left Blue Point with Mr. Leitch, six Indians, and three canoes. Four of these men, with two canoes, were to be employed in carrying on the survey, while the other two men, with the third canoe, were engaged to convey provisions into the interior, and store them in the woods at convenient points along the line of our route. Outfit.

From Lake St. John we ascended the Ashuapmouchouan. This stream, for a little over ninety-seven miles from its mouth, had been previously sur- Ashuapmouchouan.

veyed topographically by Mr. Blaiklock, P.L.S., so that, with a plan of his survey, laid down on a scale of two inches to the mile, I was able, for that distance, as we pursued our journey, to note accurately the geological and other features observed along the river. The general bearing of the course up the river from Lake St. John is about N.W. A little above the ninety-second mile the river divides into two branches. One of these comes from the N.N.E., and being the larger, is called by the Indians the Chief River. The other which we ascended, although the smaller, retains the name of Ashuapmouchouan. At the end of Blaiklock's survey, our measurements commenced, and were carried on in the usual way, the distances being determined by micrometer-telescope, and the bearings by prismatic compass, checked by opposite readings. The calculations for each day's work were made at night, and the measurements protracted in the tent as opportunity offered; so that we were able to ascertain, at any time, our position and rate of progress.

Nikoubau. Except the first mile, which is N.W., the upward course of the river, from where our measurements began, is about S.W., and the distance from Lake Ashuapmouchouan is about twenty-four miles. Leaving this lake, the upward course is generally northwesterly to the height of land which divides the waters of the Saguenay from those flowing to Hudson's Bay. This portion of the river, which is called Nikoubau River, passes through several small lakes. The first is called Lower Nikoubau, the second Nikoubau, the third Perch Lake, and the fourth Branch Lake. At the head of the latter, the river divides into two branches, one comes from the N.E., and the other, in its upward course continues north westerly, and passes a sort of double lake, called Narrow-Ridge Lake, whence the highest lake, called Whitefish

Water-shed. Lake, is reached by a portage of about one mile. This is close to the water-shed, which is also the boundary-line between the province of Quebec and the territory to the north, and is nearly seventy-two miles from the beginning of our survey, or 170 miles from Lake St. John. Continuing in a north-westerly course, we passed through several small ponds, and descended for

Abatagomaw. about two miles the stream called Two-Discharges River, which forms the outlet. This brought us to Lake Abatagomaw, traversing which advanced us a further distance of about ten miles, nearly in the same direction; thence our course was nearly at right angles to that hitherto followed, or north-easterly. Passing through some small lakes or ponds on a small stream which flows into the last-mentioned lake, a height of land is reached which divides the waters of Lake Abatagomaw from those of Lake Chibogomou. The latter lake is sixteen miles from the former, or a little over two hundred

Chibogomou. from Lake St. John. Lake Chibogomou stretches in the same (north-easterly) direction, a further distance of twenty-two miles, and empties itself by two outlets, about three miles apart, with a fall of about twenty-five feet in from 100 to 200 paces, into another lake, running parallel with it. These

two lakes, and Abatagomaw are supposed to form the head-waters of the Notaway, which is said to be a large river where it falls into James Bay. Continuing in the same direction through several small ponds, and crossing another height of land, together a distance of a little over four miles, Lake Chibogomou is reached. This lake extends in the same direction nearly twenty-four miles farther. Following the stream by which it discharges, and passing through several small ponds, a distance of four miles brings us to Abatagoush Bay, a part of Lake Mistassini. This bay was surveyed for thirty miles,—thirteen miles to the Hudson's Bay Company's post, and seventeen miles beyond it. At this point the lake opens out both to the right and left; and Mr. Burgess, the officer in charge of the Hudson's Bay Company's post, told me that from this point the western shore trends north for about six miles, where a bay, twelve miles across, called Poonichuan, stretches south and southwest for a distance of about thirty miles. He further informed me that across the bay the coast-line continues in a northwesterly direction for forty or forty-five miles farther, and thence north for about sixty miles. In some part of the latter distance is the discharge of the lake which forms the head-waters of the Rupert River. Thus, if Mr. Burgess's estimate of the distance is approximately correct, the length of Lake Mistassini, including the bays, would be about 150 miles, or but little less than that of Lake Ontario. I have no information regarding its breadth. Besides the two bays already mentioned, there is a third on the east side, called Cabistachuan, which runs to the south and west from a point about midway between the Hudson's Bay Company's post and the end of our measurements, and is about twenty miles deep. At the south end of this a stream of the same name, said to be of considerable size, enters from the eastward. Mistassini.

The whole distance from Lake St. John to the point where our measurements terminated on Lake Mistassini, by the route followed, is nearly 290 miles. It was my intention to have proceeded farther along the lake, but our provisions having failed to reach us, and being unable to procure any at the Hudson's Bay Company's post, we were obliged to return to Lake Nikoubau, where our supplies were stored. We therefore left Lake Mistassini on the 13th of August, and arrived at Nikoubau on the 20th of the same month. From the last-mentioned lake we resumed our survey. Ascending a stream called Foam-Falls River, we passed through Lakes Askatiche, Kakaskapstethiouisse and Normandin to a height of land which divides the waters of Lake St. John from those of the St. Maurice, a distance from our starting-point, in a general southwest course, of forty-one miles. Thence, continuing on about the same course, we descended a tributary of the St. Maurice, called Clear-Water River, which passes through Clear-Water and Pemacachie Lakes, and brings us in twenty-two miles to Sandy-Beach Lake. About two miles from where we entered this lake, the river St. Maurice comes in from the northwest, and at a distance of about eighteen miles it St. Maurice.

passes out by a narrow channel into Lake Traverse. The total distance to this point from Lake Nikoubau is about eighteen and a half miles. As the St. Maurice had been already surveyed from this point downward, there was no need of continuing our measurements. We therefore descended the river as far as Kirkendatch, a distance of twenty miles, noting the various objects of interest met with as we went along. Having run short of some necessary supplies, and being unable to procure them here, I was obliged to send to Weymoutachinque, a distance of sixty miles, where we got partially provided.

Kirkendatch. We arrived at Kirkendatch on the 7th of September, and on the 13th started from that place with an additional Indian as guide, for the head-waters of the Gatineau. On this portion of the journey the distances were estimated by time, except on the portages, which were paced, and some of the larger lakes, which were triangulated from a measured base. Passing from Kirkendatch through a few small lakes, we descended a stream which is the outlet of the last one, and which falls into a tributary of the St. Maurice, called Hair-Cutting River. This we descended to its source, in Great Beaver Lake, which brought us to the height of land between the waters of the St. Maurice and those of the Gatineau. This we crossed by a portage about half a mile in length to Light-Fire Lake. The distance from Kirkendatch to this point is about thirty-five miles, in a direction about south west. Light-Fire Lake is on the south east branch of the Gatineau, and several miles below its source. We descended the stream to the north-west branch, and thence to the river Desert, where we arrived on the 26th September, a distance of about 300 miles from Kirkendatch. From the Desert, Mr. Leitch and myself travelled to Ottawa, about 100 miles distant, by land, as we would thus be better able to judge of the agricultural capabilities of the country than by following the river. The Indians, however, went down the river with the canoes, and we rejoined them at Ottawa on the 30th September; the whole party arriving in Montreal on the 3rd of October, whence the Indians returned to their homes on Lake St. John.

Gatineau.

The whole of the season's work has been protracted on a scale of two inches of the mile; and the accompanying map * is a reduction from it to a scale of four miles to the inch. It must be remarked, however, that at some of the points, the distances are, for the present, only approximately given.

GEOLOGICAL DESCRIPTION.

The rocks met with may be classed under three heads, namely :—

I. Laurentian gneiss with crystalline limestones.

* The map is in manuscript. The publication of it is deferred pending further Surveys and Explorations in the region.

II. Crystalline schists, consisting of chloritic and epidotic rocks, with dolomites, serpentines and conglomerates.

III. The nearly horizontal fossiliferous limestones of Lake Mistassini.

I. Laurentian.

The rocks of this system cover by far the larger part of the area examined. As their character is, on the whole, very uniform, and they have been so often described, it will only be necessary to notice them very briefly, proceeding from south to north on the two lines of exploration. The first line, as already explained, is from Lake St. John, on the Ashuapmouchouan River, to Lake Nikoubau. The second is from the river Desert, up the Gatineau, to Kirkendatch on the St. Maurice; thence up the St. Maurice to its tributary, Clear-Water River; thence up that stream and down Foam-Falls River, to Lake Nikoubau; thence to Lake Abatagomaw, where other rocks make their appearance. Laurentian.

From Lake St. John to the Water of Sandy-Banks, thirty-six miles up the Ashuapmouchouan, the rocks are well seen at the portages, the first of which is named Rocky Portage, followed by St. Ange, Bear, Little Bear, and Stony Portages. At all of these, the rock is fine and coarse-grained red and grey gneiss, with some black hornblendic beds, and others with a good deal of black mica. The dip is from southeast to east, at an angle of from 40° to 90°. From the Water of Sandy Banks to the Chaudière Falls and Rapids, a distance of fifty-six miles from Lake St. John, the rocks are seen in almost continuous cliffs, enclosing the rapid portions of the room. The dip is still easterly, and the character of the rock is much the same as below. Immediately below the falls, a layer of pinkish granular limestone, about six inches thick, was observed interstratified with the gneiss. At the falls, on the west side of the river, the gneiss is cut by numerous granite veins from a few inches to thirty-two feet across, composed of large crystalline masses of reddish and yellowish orthoclase, black crystalline hornblende, vitreous quartz, and small portions of crystalline magnetic iron ore. The strike of these veins is N. 73° E. and S. 73° W. Although here the general dip is about S. 87° E. $< 45°$, the strata are much contorted and broken. A little above the Little Chaudière Falls, a mile farther up than the point last indicated, a bed of limestone a foot thick occurs in the gneiss. It is crystalline and of a pinkish color, but in some parts grey, and holds grains of green pyroxene. Gneiss of the ordinary character, is the prevailing rock, as far as the sixty-sixth mile; but at this point, fine and coarse grained grey gneiss and black mica-schist become interstratified with crystalline grey limestone. This is seen pretty continuously on the sides and in the bed of the river, for a distance of two miles, or to Pike River; at the sixty-eighth mile from Lake St. John Gneiss rocks. Granite veins. Limestone.

it has a breadth of about fifty yards, and dips N. 75° E. < 39°, giving a thickness of about ninety feet. A little farther up, however, at a bend in the river, beds are seen, which, like the above, are limestone, and which, although much concealed, may give a breadth of a hundred yards, or a total thickness of 180 feet. The beds which apparently underlie these limestones, form a mass of about sixty feet thick of fine and coarse grained red and grey gneiss, followed by about fifty feet of vitreous quartz rock in beds from two inches to two feet thick. Continuing up the river, the dip is still about east; but, immediately above the forks, it is S. 46° E. < 56°, and, at the end of Blaiklock's survey, E. < 46°. From the Forks to a little above the last mentioned point, the river runs nearly across the stratification; while above and as far as Lake Ashuapmouchouan to Lake Nikoubau, the rocks are not well exposed, but, on the upper half, the dip was observed to be from S. 11° W. to S. 14° E. < 32° to 35°. At the lower end of Lake Nikoubau, the dip is from S. 84° E. to S. 14° E. From the Forks to this last-mentioned point, the rocks are red and grey gneiss, both fine and coarse grained, with black hornblende-rock, and beds of black mica-schist.

Quartzite.

River Desert.

I will now describe the second line of exploration; that, namely, from the river Desert. On the west side of the Gatineau, just below its junction with the Desert, on the hill behind the R. C. church, a coarse greyish feldspathic gneiss, with fine and coarse crystalline hornblende-rock, holding nodules of magnetic iron ore, is exposed. At the foot of the hill, and close to the Gatineau, there is a bed of grey crystalline limestone, about twenty feet thick, which has been quarried for burning into lime. This is overlaid by black hornblende-rock. The dip, although irregular, is about east, and the limestone may belong to a band which is seen on the east side of the river a little above, and which continues on the same side to a point opposite the Deseau Portage, about three miles above the Desert. At that point the dip is S. 74° E. < 65°, while about three miles farther on, at an easterly stretch of the river, the limestones appear, dipping N. 41° E. < 66°. Following this easterly stretch about two miles to Joseph Portage, the limestones are found to be overlaid by gneiss, but are again seen at the Castor-Blanc Portage, and at the Big-Eddy Portage. Below the last-named portage, the rock is largely exposed in the river-banks. On the east side of the river, at the eddy, moderately fine grained red and grey feldspathic gneiss is seen, dipping N. 72° E. < 66°. The limestones re-appear at Brulé Portage; and at Mountain Portage, where the dip is S. 67° E. < 35°, and also on the river farther up, at Backing-up Portage. Above this, the limestones are not seen for two miles, to the upper line of the townships of Easton and Sicotte, where limestones are again met with; but, whether they belong to the same band as those below is not known. Above the line referred to, they are pretty generally seen along the river for four or five miles, to within about one and a half miles of the river St. Jean de Terre. Their dip here is from S. 58°

Limestones.

E. to S. 35° E. < 30° to 32°, with one or two dips in an opposite direction. Proceeding upward, the rocks are varieties of red and grey gneiss, with beds in which hornblende and black mica predominate, to about three miles above Baskitong River, where a small exposure of crystalline limestone is seen interstratified with gneiss and dipping N. 89° E. < 30°. Above this, only gneiss was seen to a little beyond Farm Island, one of Messrs. Allan Gilmour & Co.'s farming establishments. Here another limestone exposure occurs, similar to the last, and dipping N. 36° E. < 50°. Above this, no limestone is met with for several miles. At Sturgeon Portage, the rock is grey gneiss with black mica-schist and hornblende-rock. The bedding is well marked, but the beds are much broken and contorted; and they are cut in all directions by red feldspathic veins from a few inches to several feet in width. The dip is sometimes north as well as south, and, in both cases, it is at a high angle. At the Serpent Portage, three miles above Sturgeon Portage, the rock is yellowish-grey fine grained gneiss, dipping N. 87° E. to S. 67° E. <10° to 32°. About three miles farther, at the Otter Portage, where the river bends more to the southeast, limestone is again seen interstratified with the gneiss, and dipping S. 38° E < 32°. It is again met with at Dog Portage, and on the river beyond, the rock generally running with the river. From Otter Portage, limestone is generally seen associated with the gneiss for a distance of about fifteen miles up the river, to a point about sixteen miles below the junction of the northwest and southeast branches of the Gatineau. At this point the dip is S. 77° E. < 25°, which corresponds to a strike that would carry the limestone and associated beds to the westward of the river. However this may be, no limestones were observed above this, and up to the Forks the only rocks seen were varieties of gneiss, and hornblende-rock.

Gneiss and limestone.

Without further and more detailed examination, it would be impossible to say whether these limestones, which are so largely displayed along this portion of the river Gatineau, form one or more bands. The thickness of the limestone, in some parts, cannot be short of five or six hundred feet, and, below the Big Eddy Portage, may perhaps reach a thousand feet.

Thickness of limestone.

About a mile below the Forks, the dip is N. 2° E. < 70°, while at the Forks, it is N. 32° W. < 65°, this latter dip being in a direction opposite to that of the general dip lower down. The direction of dip as far as observed, is northwestward at an angle of from 30° to 42°, for about twenty-four miles above the Forks, at the end of which distance it is S. 36° E. < 36°. About thirty-eight miles farther up, at a great bend of the river to the westward, the dip is S. 47° E. < 34°, while ten or twelve miles farther, a little below White-Bear Lake, it is S. 58° E. < 50°, and, on the portage between the Gatineau and Hair-Cutting Lake, it is S. 29° E. < 50°. The rock here is a grey gneiss, sometimes coarse-grained with black mica. Following Hair-Cutting River down for about twenty-four miles, the rocks vary but little in

character or dip, the latter being from S. 9° E. to S. 51 E. < 28° to 65°. Crossing thence to Kirkendatch, a distance of about ten miles, there is no change; but, at the west end of Loon Lake, about two and a-half miles from Kirkendatch the dip is E. < 21°. About two miles above Kirkendatch, on the St. Maurice, the rock is yellowish-grey fine-grained gneiss, dipping E. < 34°. Farther up, and about four miles below Lake Traverse, the rock is the same, with a dip S. 81° W. < 25° to 30°; and, on the west side of Sandy-Beach Lake, at a point about four miles above Lake Traverse, the dip is from S. 36° W. to S. 81° W. < 23° to 30°. About ten miles up the last-mentioned lake, the rock is a fine-grained greenish-black hornblende-rock, without any appearance of stratification, and this is seen to within a mile and a half of where the St. Maurice falls into the lake. At that point, however, with the exception of a little quartz, it is entirely composed of large crystals of hornblende. Associated with this coarse variety, in bands of from one to nine inches thick, and running through the hornblende in various directions, there is a coarsely crystalline limestone, of a pale yellowish color and weathering brown, enclosing cleavable rhombohedral masses of a browner weathering iron-spar, and plates of a pale greenish chloritic mineral. On the shore, about one mile north of where the St. Maurice enters the lake, the rock is grey and flesh-colored feldspathic gneiss, containing crystals of greenish-black hornblende, and dipping S. 4° W. < 30°. Near the upper end of Lake Pemscashie, the rock is mostly hornblendic, with some interstratified reddish-colored gneiss, dipping S. 71° E. < 41°. Similar rocks are seen in several places up Clear-Water River. At the lower end of Clear-Water Lake, the dip is S. 24° E. < 31°; and, about the middle, the grey variety of gneiss, associated with hornblende-rock, dips S. 24° E. < 31°. Across the water-shed, on Lake Normandin, the dip is S. 9° E. < 46°, the rock having much the same character as before. Following Foam-Falls River downward to the falls, similar rocks are met with, the dip at the falls being S. 9° E. < 39°. Here the strata are cut by veins of light-colored crystalline feldspar, from six inches to one foot thick. From Foam Falls through Lake Kakaskapstethiouisse, thence to and along the shores of Lake Askatiche, and from that lake down the river to Lake Nikoubau, the rocks vary very little in character. The dip is from S. 83° E. to S. 39° E. < 40° to 45°, except near the outlet of Lake Kakaskapstethiouisse where it is for a short distance seen to be N. 11° W. < 68°. As already stated, at the lower end of Lake Nikoubau the dip is from S. 64° E. to S. 39° E. < 40° to 46°. Here the rock is composed of coarse-grained grey gneiss, with an occasional tinge of red, and holding considerable black mica. Interstratified with this, are finely crystalline hornblende beds, which decompose rapidly where exposed to the weather.

St. Maurice.

Hornblende rock.

Lake Nikoubau.

From Lake Nikoubau to the height of land between the waters of the Saguenay and Hudson Bay, the rocks, as far as observed, are, on the whole the same as those described as occurring at the lower end of Lake Nikoubau;

but the dips are less uniform. About the middle of the lake, it is S. 33° W. < 58°, while, on the Whitefish Lake, it is N. < 85°. Beyond the height of land, the only exposures observed were on Height-of-Land Lake, and at Cypress Portage. Here the rocks are still of the same character. From Cypress Portage down Two-Discharges River to Lake Abatagomaw, no exposures were met with; but, on the island in the lake, the rock is granitic, showing no appearance of stratification. Some varieties are composed of yellowish feldspar, not very coarse grained, with vitreous quartz and some hornblende; while in others the feldspar is not so abundant, but is more coarsely crystalline, and nearly white, with white vitreous quartz and scales of black mica. Near the north end of the main body of the lake, a few beds of gneiss are seen dipping N. 84° W. < 31°. The lower beds are composed of whitish feldspar, with quartz of the same color, and black mica; while overlying these are about two feet of a rock composed chiefly of whitish quartz and fine scales of silvery mica. With the exception of these last, all the rocks examined on the lake, up to this point, as has been already stated, show no signs of stratification. It is, therefore, doubtful whether they belong to the stratified masses of the Laurentian system, or whether they are intrusive. To determine this point, further exploration will be necessary. In the mean time, it will be convenient to consider them Laurentian, and to take the point indicated above, near the north end of the main body of Lake Abatagomaw, as their limit in this part, beyond which, rocks of the second great series already mentioned, almost immediately make their appearance.

Granitic rocks.

It will be observed that, in describing these ancient rocks, I have not in any way indicated what their structure or volume may be. Indeed, from the great sameness in their lithological characters, and the absence of fossils, it would be hazardous to do so. The only reliable means of determining their structure, is to trace out continuously, beds lithologically different from the general mass. So far as known, the only beds in the Laurentian system suited for the purpose are the crystalline limestones. These were met with only on a small portion of the lines of exploration followed. Of these limestones, Sir W. E. Logan thus speaks, *Geology of Canada*, 1863, page 42:—"Bands of crystalline limestone are easily distinguished from bands of the gneiss, but it is scarcely possible to know from local inspection whether any mass of limestone in one part is equivalent to a certain mass in another. They all resemble one another lithologically, and although masses dipping in the same direction are met with running for considerable distances rudely parallel with one another, it is scarcely ever safe to take for granted that they are stratigraphically distinct. The dips avail but little in tracing out the structure; for, in numerous folds of the series, the dips are frequently overturned; and the only reliable mode of pursuing the investigation, and working out the physical structure is, patiently and continuously to follow the outcrop of each important mass in all its windings, as far as it can be traced;

until it becomes covered up by superior unconformable strata, is cut off by a fault, or disappears by thinning out. A labor such as this, in a district without roads, and the topography of which is yet little known, with a surface much broken by the unequal wear of its rocks, and still covered by forest, must necessarily require much time." From these remarks, it is apparent that the facts contained in the present report can only be looked upon as a first contribution to our knowledge of the geology of this region.

II. Crystalline Schists and Serpentines, with Conglomerates.

This series was first observed at the north end of Lake Abatagomaw. Thence it occupies the country along the line examined, to and along Lake Wakinitche, including Lake Chibogomou, and the lakes and portages between it and Abatagomaw. The last of it was seen at about two miles beyond the outlet of Lake Wakinitche, nearly four miles in a straight line from where it was first observed on Lake Abatagomaw.

As already stated, the rocks of this series are met with almost immediately succeeding the Laurentian, near the north end of Lake Abatagomaw. Beyond this, they are well seen in a narrow bay, running for several miles in a direction nearly east, where they occur both on the shore of the bay, and on islands. The rocks here are green chloritic slates. In some places they contain crystals of hornblende; and are occasionally interstratified with dolomitic beds weathering brown. The dip along this stretch is from N. 31° W. to N. 3° E. < 44° to 68°. On the first portage beyond this bay, there are considerable exposures of flattened spheroidal or reniform masses, from a few inches to upwards of a foot in diameter. They are made up of an indurated greenish and purplish argillaceous rock, which is jaspery in its texture. When sections of these spheroids have been exposed to the weather, they present a concentric arrangement of various shades of color, becoming lighter towards the centre. The strike of these rocks is N. 61° E. and S. 61° W. To the end of the second portage, the rock is a greenish chloritic slate, becoming, in places, epidotic and dioritic, the latter variety assuming a reniform structure, and holding, between the concentric layers, a soft dark greenish mineral, resembling serpentine. The next exposure is a little beyond the entrance to Lake Chibogomou, and is the only one met with for about four miles, on the main west shore, or on the islands immediately to the eastward. It is a quartzose feldspathic rock, with films of a greenish chloritic mineral. The feldspar is yellowish, and the quartz greenish in hue. On an island, about seven miles from the entrance to the lake, the rock is very similar, except that the chloritic mineral above-mentioned occurs only in spots. Between the last two exposures, but somewhat to the eastward of them, there are two islands, composed of a yellowish micaceous granite. For the next

Chloritic slates. Dolomites.

Dioritic and epidotic rocks.

four miles, as far as observed on the northeast side of the lake and the islands adjacent, the rocks are a light-grey and yellowish felsite, with quartz and minute scales of mica or talc. In some places, these are associated with a green dioritic rock, in small bands of from one to four feet wide, the strike of which is S. 33° E. and N. 33° W. If this banding is due to bedding, which is doubtful, it is the only indication of lines of stratification observed, thus far, on the lake.

The next point at which the rocks are seen on the same side is just before reaching Paint Mountain. Here it is a green chloritic rock, weathering to greyish-green, and holding considerable quantities of magnetic iron ore disseminated in grains and crystals. Still closer to Paint Mountain, on the shore, the rocks are green chloritic slate, with no well defined bedding. Here the yellow sulphuret of copper, which is described farther on, occurs. These rocks are also more or less charged with fine-grained iron pyrites for a distance of about a mile, to a point immediately below Paint Mountain, which rises above the lake, in a short distance back, to a height of 250 feet. In one place, there is a depression running up the mountain from the lake, thirty feet wide, filled with drift. The strike of this depression is S. 61° W. and N. 61° E. On Sorcerer's Mountain, which rises, on the southeast, to a height of 425 feet above the lake, the rock is green chloritic slate, with small specks of iron pyrites disseminated irregularly through it.

In the narrows of the northeast end of the lake, the rock is a conglomerate and breccia. In some parts, it is made up of small fragments of the rocks already described; consisting of yellowish feldspar and quartz, green chlorite, serpentine, and epidote; while in others, the pieces are from a few ounces to one hundred pounds in weight. Large expanses of conglomerate are likewise entirely composed of rounded fragments of Laurentian gneiss of grey and red colors, the latter predominating. Other exposures show a conglomerate made up of angular and rounded fragments from an ounce to a ton weight, in a matrix of finer material of the same kind. Conglomerates.

These conglomerates are succeeded by serpentines and associated rocks, which make their appearance immediately to the west of the first portage leading from the lake. About 200 yards west of the portage-road, a cone-shaped hill, which rises over the waters of the narrows about 160 feet, is entirely composed of serpentine. This rock is traced, on one side, to the portage, and on the other it is supposed to form part of Juggler's Mountain, which is about 400 feet high, and is about two miles distant, bearing S. 41° W.* On the highest part of the cone referred to, there is a blackish limestone, about one foot thick, interstratified with serpentine. Dr. Hunt, while examining these rocks, had a portion of the limestone sliced for examination Serpentine.

* The bearings here are very uncertain, as at the beginning of the portage the local attraction was equal to 146°, which gradually diminished for a distance of about half a mile on either side, where the compass gave the true bearings.

under the microscope, which revealed a structure resembling that of some coral. The serpentines, which are dark-colored, opaque, and contain much disseminated magnetic iron, yield by analysis considerable portions of chrome and traces of nickel. On an island opposite the portage, the rock is blackish-blue hard slate, rarely with what appear to be small grains of whitish feldspar. On the various portages and small lakes passed over from this point to Lake Wakinitche, the only rock seen is chloritic slate. The same remark applies also to the lake itself, from its southwest end, along the southeast side, to within six miles of its outlet. In this last distance, and for a mile beyond the outlet, only conglomerate rocks are seen. These resemble the two varieties already described. On the northwest side of the lake, about the middle, these rocks rise to a height of 150 or 200 feet, forming a bare escarpment, extending for about four miles; and, on the same side, near the outlet, Wakinitche Mountain, which is entirely composed of them, rises about 350 to 400 feet high, for the most part bare and rocky, and extending along the margin of the lake for nearly three miles. The fragments in the conglomerates in the two last localities are chiefly of Laurentian rocks, and the enclosed masses are often many tons in weight. In some parts, without close examination, the conglomerate might be mistaken for Laurentian gneiss. In many parts of this hill considerable exposures of red shale are met with, as well as grey and chocolate-brown sandstones made up of fine grains of reddish feldspar and white quartz. Although lines of deposition were observable in these sandstones, I could trace no regular line of strike or dip.

Conglomerates.

Sandstones and shales.

Whatever the geological horizon of this series of rocks may be, it will be prudent for the present to withhold an opinion until further investigations are made. The only indication of their geological age is that afforded by the fossil already mentioned as occurring in limestone interstratified with serpentine. This, Mr. Billings thinks, is a coral, but not determinable generically. In regard to their relative position, it is evident that the conglomerate is the upper rock; but, from the general obscurity of the bedding, no estimate of the thickness can be arrived at. The average strike, however, appears to be with the run of the lakes, or S. 22° W. and N. 22° E. This would, at Wakinitche Mountain, give the whole a breadth of about twelve miles in a south-easterly direction, where, if their outcrop is continuous, they would come in contact with the Laurentian rocks.

III. Fossiliferous Limestones.

About a mile beyond the outlet of Lake Wakinitche limestone is met with in angular pieces on the surface, and is almost the only loose rock seen as far as Abatigoush Bay on Lake Mistassini, where limestone beds were observed in place. They are occasionally seen on the islands, and on the main land as far as the lower end of Cabistachuan Bay, where the main

body of the lake opens out to the northward; a distance of over thirty miles from where the limestones first make their appearance. About four miles southwest from the narrows on the northwest side of the lake, the dip of the beds is N. 61° E. < 4° to 6°, but a mile farther southwest they have no perceptible inclination, and about one mile northeast from the Hudson's Bay Co.'s Post, dip nearly E. < 3° to 5°. Wherever an exposure was met with, the rock was very uniform in character, occurring in beds of from an inch to two feet, generally of a grey earthy limestone, interstratified with darker grey beds of from two to four inches. The lower beds are compact and dove-colored, and are from five to six inches thick. In many of these small geodes or rounded masses of black chert occur, often containing in the centre a portion of black soft carbonaceous material. Many of these cherty masses, as well as of the surfaces of many of the beds of limestone, are thickly marked with what appear to be shrinkage-cracks. Some beds are curiously water-worn, looking as if they had been rounded and grooved for ornamental purposes. Flat limestones

The only fossils observed were an orthoceratite and an obscure coral, neither of which could be determined. Fossils.

Economic Minerals.

Copper.—Copper-pyrites has already been mentioned as occurring in the neighbourhood of Paint Mountain, on Lake Abatagomaw. At a point a little to the southwest of the mountain, on the lake-shore, this ore is met with in specks, together with stains of the green carbonate, but no well-defined bed or vein was observed. The rock is a green, slightly calcareous, chloritic slate. These indications of copper are seen for nearly half a mile northeasterly along the lake-shore to another point, where a bed or vein two feet thick, containing copper,-pyrites is seen in chloritic rock for about twenty feet. Its strike is N. 31° E. and S. 37° W., the underlie not being determinable. The portion of the vein exposed would probably yield four or five per cent. of copper throughout, while parts of it might produce ten or twelve per cent. For about three-quarters of a mile farther along the shore, specks of the yellow sulphuret and the green carbonate of copper are met with wherever the rock appears. At the end of this distance, and just under Paint Mountain, the rock is largely charged with fine-grained iron-pyrites and specks of yellow sulphuret, in a yellowish quartzose gangue. Here the iron-pyrites constitutes as much as fifteen or twenty per cent. of the rock, while along the whole of the distance above described, about one and a quarter miles, it is never absent, though occurring in small quantities. At the last-mentioned place is the depression described on page 293. As before stated, it is filled with drift, and no rock is seen in it; but from the quantities of iron and copper-pyrites met with in the rock on both sides of Copper ore.

it, it is quite possible that under the drift a valuable deposit of copper ore may exist.

Iron ore.

Iron.—About half a mile southwest of the first-mentioned copper ore, and near the lake-shore, there is a deposit of magnetic iron ore in chloritic slate; its breadth is fifty feet, and it is seen on its strike, which is S. 65° W. and N. 65° E., about 200 paces. The ore occurs in crystalline lumps and grains throughout the rock. The whole fifty feet would probably yield an average of from fifteen to twenty per cent. of iron.

Ochre.—The only place this was observed was in the northeast part of Paint Mountain, where a small deposit was met with about half-way up the mountain, which probably derives its name from the presence of this ochre or paint.

Lime.—In all the localities where limestone has been described, it is abundant, and suitable for lime-making.

Building-stone.—It would be useless to take up space by specifying each locality where material of this kind could be got, as it is abundant throughout the Laurentian series, as well as in the flat limestone formation around Lake Mistassini.

Character of the Land.

Valley of the Ashuapmouchouan.—The country around Lake St. John has already been described in the Geological Report of 1857; and its character for fertility is likewise well known from many other sources.

Ascending the river for thirty-six miles, the country differs but little from that around the lake, being underlaid with clay, which forms an excellent soil. In many places this becomes covered with sand and sandy loam; and towards the thirty-sixth mile, the sand-hills predominate, rendering the land less fit for tillage than lower down. The sandy ground, however, is small in proportion to what appears to be really good soil. Settlement has already ascended the river for about ten miles from Lake St. John, where I was told, and from observation have every reason to believe, that all kinds of grain, and many vegetables yield well. A field of spring-wheat, five or six acres in extent, had a healthy and luxuriant appearance on the 23rd of June. From the thirty-sixth mile upward, the country near the river becomes rocky, with but little soil. Occasional spaces of from a few acres to probably fifty or a hundred acres in extent, are covered with sand, very often coarse, and abounding in rounded gneiss boulders of from an ounce to 100 pounds weight. The gneiss hills rise from 150 to 300 feet, and one, called Hawk Mountain, close to the east side of the river, rises about 500 feet. As far as the Shecobish River, fifty-eight miles from Lake St. John, the country presents a similar aspect. The river itself is almost a continuous rapid; its height above the sea-level at the thirty-sixth mile is 512 feet,

while at the Shecobish it is 853 feet, being a rise of 341 feet in twenty-two miles. Included in this are the Chaudière Falls and Rapids, 121 feet, which extend over somewhat less than one mile. From the Shecobish to La Loche Brook, the aspect of the country remains the same, but the river is less rapid, the height being here 939 feet, a rise of eighty-six feet in twenty-three miles. From the La Loche Brook to the Forks, the hills rise from eighty to 300 feet, but are still covered with a sandy soil, and occasional sandy patches filled with gneiss boulders.

The whole of the country from Lake St. John to the Forks was burnt over last summer, except some islands, and patches of no great extent in low places near the river. The trees of this burnt district, so far as observed, appear to have been principally spruce, balsam-fir, white birch, poplar, mountain-ash, and a shrub-like white cedar. The spruce is from twelve to eighteen inches in diameter, and from forty to eighty feet high, the other trees being of less size.

From the Forks upwards to within six or seven miles of Lake Ashuapmouchouan, the surface is comparatively level. Near the river considerable deposits of brown sand prevail, often filled with the usual rounded gneiss boulders. These boulder-sands have frequently a thickness of over one hundred feet. In many places where the surface is bare of vegetation, the finer sands are drifted into low ridges and hillocks by the winds. From one to three miles back from the river, on either side, rocky ridges of gneiss protrude through the sands, and rise from one to two hundred feet above the level of the river. On the sandy spaces but little vegetation is met with, and only a few small white birches and a species of pine,* locally called cypress, grow on the gneiss hills. Although bare rocky spaces occur, considerable areas are covered with white birches, apparently of ten or twelve years growth. There are indications that a previous forest, but of no great size, has been destroyed by fire. The river along this stretch is full of rapids. In one place between the ninety-eighth and one hundred and second miles there is a rise of 115 feet; the height above sea-level at the latter point being 1,115 feet, while in the next nine or ten miles the rise is sixty-five feet, reaching 1,180 feet above sea-level. From this last place to Lake Ashuapmouchouan, the country seen is low near the river and lake, the soil mostly a sandy loam, and well fitted for cultivation. The wood is spruce and tamarack, both of which attain a good size, while balsam-fir and white birch are rarer and smaller. At this lake, on the site of an old Hudson Bay Co. post, in the clearing around the old buildings, as well as in open places near the lake and river, the coarse grass was from three to four feet high, while timothy-grass was two feet high on the 9th July. Blueberries were ripe by the 5th or 6th, and raspberries on the 7th or 8th of July. The height of this lake is 1,184 feet above the sea.

Sands.

Vegetation.

The same character of soil and country prevails up the Nikoubau River

Nikoubau

* *Pinus Banksiana*, also known in that region as scrub-pine. [T. S. H.]

from the lake to Pole Rapids, a distance of about seven miles; but at these rapids, and above this to Lake Nikoubau, the banks are composed of brown sand with gneiss boulders, the latter occasionally large, and often so numerous that the whole deposit resembles a coarse boulder-drift, with its interstices filled by sand. The country rises above the river from twenty to eighty feet, and the boulder-deposit is occasionally interrupted by gneiss hills of from eighty to two hundred feet high. Much of the forest appears to have been burnt from ten to twenty years ago, and these portions have a thin growth of small white birch and cypress, and often abound with blueberry bushes, which, at the time of my visit, were covered with ripe fruit. Where the woods have escaped the fire, they consist of spruce, balsam-fir, tamarack, poplar, and mountain-ash. At Lake Nikoubau these all attain a good size.

Gatineau.

Gatineau River from Desert River to Height of Land.—The estimated height above the sea-level of the Gatineau at the River Desert, about one hundred miles due north from Ottawa City, is 369 feet. At this point, and for six miles further up the Gatineau, the soil is a sandy loam, the general level of the country being from twelve to thirty feet above the river, although rocky hills of a hundred feet are seen occasionally. Along this distance a considerable quantity of land was under cultivation with oats, barley, pease, and spring and fall-wheat. Several fields of the last looked healthy, and covered the ground well on the 26th of September. I was informed that the yield is from twenty-five to thirty bushels to the acre. Potatoes appear to yield well, and were found to be of excellent quality. Above this there are no settlements, and the only cultivation is on the farms of lumbering establishments. One of these is Farm Island, belonging to Messrs. Gilmour & Co.; the next and highest up belongs to Messrs. Hamilton Bros. Here I was furnished with the following facts by Mr. Grant, the Superintendent. The clearing is about 400 acres in extent, producing 140 tons of hay, 3,500 bushels of oats, 200 bushels of pease, fifty bushels of buckwheat, 1,300 bushels of potatoes, with barley, turnips, and mangold-wurtzel, the quantities of which I did not ascertain. There are three other farms in the neighbourhood, collectively of 350 acres, producing 180 tons of hay, 3,000 bushels of oats, 100 bushels of pease, and 1,400 bushels of potatoes. I am not aware whether wheat has been grown. These farms are chiefly for providing food for the horses and oxen used for drawing the lumber in winter.

Cultivation.

It appears to me that the above facts indicate that the country is well adapted for settlement. The soil is very similar to that at the River Desert, a sandy loam; and as far as observed it is very much the same for a distance of over fifty miles along the Gatineau from the mouth of the Desert. The banks of the former river are from twenty to fifty feet high. Rocky hills from 100 to 150 feet high sometimes rise from them, but are oftener at some distance back. Besides the great quantities of pine which this district is known to produce, it also contains spruce, balsam-fir, some black birch, as well as considerable areas of white birch, with occasionally white and brown ash.

Curiously enough, where maple is met with, it is in groves on the most elevated points. The river, excepting at the portages, is generally lake-like, and from 100 yards to not less than half a mile wide. There are in all ten portages, varying in length from fifty yards to about one mile. The total rise from the Desert to Hamilton's farm is 142 feet, making the latter about 512 feet above the sea. From Hamilton's farm to the junction of the northeast and southeast branches, a distance of about forty miles, the aspect of the country remains the same, except that pine timber gradually becomes smaller and more rare. There is reason to believe that for a great portion of these forty miles the forest was burnt seventy or eighty years ago, and its place is now occupied by a second growth of white birch. Pines are seen overtopping them; in many places these are numerous, and judging from their appearance, they are of comparatively recent growth, very few of them being more than a foot in diameter. It would be for the interest of the country to have these young forests protected from the lumbermen for many years to come. Gatineau.

The character of the river for about ten miles above Hamilton's farm is the same as below; in this distance four portages are passed, with a total rise of 114 feet. Above this the river becomes rapid, without portages, and narrower, the additional rise to the Forks being 185 feet, making the latter 815 feet above the sea. For about twelve miles up the southeast branch, the river is rapid, and rises nearly 300 feet, reaching 1,015 above the sea. The river is from half a chain to two chains wide, with rocky banks rising into broken rocky hills from seventy to 100 feet high, covered with a scanty sandy soil, supporting principally white birch, with here and there pines similar to those below the Forks. I may here remark that no hardwood trees, such as maple, black birch, elm, and ash, were observed above this. One small ash tree was, however, seen at the end of the distance.

For the next twenty-five miles the river is less rapid, the rise being only sixty-five feet. The country is low, with few elevations over fifty feet. The soil is sandy, but supports a large growth of spruce, balsam-fir, white birch, tamarack, and poplar, and a few pine trees of small size. Here, about 230 miles northward of Ottawa City, and 1,080 feet above the sea, appears to be the northern limit of pine on this branch of the Gatineau. The succeeding twelve miles is hilly, but well wooded with spruce, balsam-fir, tamarack, and white birch. The hills are from 150 to 450 feet high, shewing occasionally bare rocky summits and escarpments. This is succeeded for about ten miles by bare rocky hills, 100 to 500 feet high, with terraces of boulder-sand from twenty to thirty feet high. Near the river, on both sides, small thinly scattered poplar, cypress, and white birch are seen. To Marten River, three miles farther, the country is lower, rising above the river from twenty to 150 feet. The timber is of good size, the spruce and tamarack being from twelve to eighteen inches in diameter, and from seventy to eighty feet high. The country and the timber retain the same character to White Bear Lake, about

nine miles farther. The river up to this point is full of rapids, shewing a height above the sea of 1,450 feet. Beyond this to the height of land the stream rises to 1,500 feet above the sea. The aspect of the country is the same, except three or four miles to the southeast, where rocky hills are seen 300 or 400 feet in height, having a blackened appearance from recent fires.

The portage from White Bear Lake to Hair-Cutting Lake is about half a mile; the summit is 1,514 feet above the sea, and only four feet above the latter lake, making here a difference of only ten feet between the waters of the Gatineau and those of the St. Maurice. Along Hair-Cutting Lake, which is about seven miles in length and from two chains to about two miles wide, is a level plain rising over the lake from ten to twenty feet, composed of brown sand, and mostly bare of vegetation. Along the lake-shore, where the waves have acted on the sand, iron-sands like those of the lower St. Lawrence are met with. Proceeding down Hair Cutting River to Great and Little Beaver Lakes, the country continues comparatively level, and consists of sandy plains, rising in terraces sometimes sixty feet over the river, and covered mostly with blueberry bushes, and here and there remains of small burned spruces. From these lakes to where the traverse leaves Hair-Cutting River, and thence to Kirkendatch on the St. Maurice, a distance of about eighteen miles, the country is still covered with brown sand, and the inequalities of the surface are from twenty to one hundred and twenty feet high. This region as far as Loon Lake is well wooded with spruce, tamarack, white birch, and some balsam fir. To the north of Loon Lake, and thence to Kirkendatch, there is a level plain of brown sand of several square miles in extent. This plain, which rises sixty feet over the St. Maurice River, has been covered with a growth principally of spruce trees from six to nine inches in diameter, but these have nearly all been destroyed by the frequent fires which have passed over this district. On the St. Maurice below Kirkendatch, the country is more elevated and rocky and, for some distance at least, the woods seem likewise to have been destroyed by fire. The height of the St. Maurice above the sea at Kirkendatch is 1275 feet. Following the St. Maurice upward to the upper end of Lake Traverse, the country is comparatively level, and the river for considerable distances winds through extensive flats of sandy loam, which are covered by water in the spring-time, and during floods. Some of these produce an abundance of wild grass, which would support many hundred head of cattle, Mr. Spence, the Hudson Bay Co's officer at Kirkendatch, told me that the few cows which he keeps thrive remarkably well, pasturing in summer on the flats, while in the winter they are fed on the wild grass cut and dried to hay. The rise in the river from Kirkendatch to Sandy Beach Lake, which is immediately above Lake Traverse, is fourteen feet, making the latter 1,289 feet above the sea. Lake Traverse, which is about eighteen miles in length and from a few chains to two and a half miles wide, has banks of sand rising from ten to forty feet above the water. Some hills two or three miles from the lake rise from 100 to 300 feet, and others six or seven miles southeast

St. Maurice

Kirkendatch.

from the lake, attain from 400 to 600 feet. The woods are spruce, tamarack, balsam-fir, and white birch; the spruce and tamarack trees being from six to twelve inches thick at the base. The River St. Maurice, which, as already stated, falls into this lake one and a half miles below the northeast end, is about five chains wide.

In ascending the Clear-Water River, a tributary of the St. Maurice, through Pemscachie, Watoush, Fishing, and Clear-Water Lakes, to the Height-of-Land Portage, a distance of about seventeen miles, the country bears the same level aspect as on Sandy Beach Lake. For nearly half this distance the woods have been burnt, considerable areas now producing only small cypresses, about four or five feet high. Where the forest has not been burnt, the sandy soil produces a smaller growth of timber than on Sandy Beach Lake. The river in this distance, to the Height-of-Land, rises only 131 feet, reaching 1,418 feet above the sea. The distance from the Height-of-Land down from Falls River, through Lake Normandin, Kakaskapstethiouisse, and Askatiche, to Lake Nikoubau, is about thirty four miles. For the whole of this distance, the description given of the country along Clear-Water River is equally applicable. It presents the same alternation of green and burnt woods, as well as the comparatively level, barren, sandy soil. The height of Lake Nikoubau is 1,266 feet above the sea, showing a fall 152 feet from the Height-of-Land.

Height of Land.

Lake Nikoubau.

Lake Nikoubau to Lake Mistassini.—The distance from the lower end of Lake Nikoubau to the Height-of-Land, in a straight line, is about fifteen miles; but by the river and lakes it is about twenty four miles. In this distance the woods are generally green, and in a few places,—one at the lower end of Lake Nikoubau, a second at Perch Lake, and a third at Narrow-Ridge Lake,—the timber is of good size. There are a few hills that rise from 100 to 300 feet. Patrick's Mountain, to the west of Narrow-Ridge Lake, rises over the lake about 500 feet, and is covered principally with white birch trees, five to eight inches in diameter. The soil is still sandy, as far as observed, over the whole distance. The Height-of-Land, which is the northern boundary of the province of Quebec, is here 1,359 feet above the sea. It rises ninety-three feet above Lake Nikoubau, but only fifty-three feet above its head-waters, and only twenty feet above the water that runs to James's Bay. The length of the portage which divides these waters is not quite half a mile.

Lake Mistassini.

From the Height-of-Land to Lake Abatagomaw, about five miles, the country is somewhat more uneven, but still sandy and barren, supporting for the most part small cypresses, with some spruce and white birch. The fall to the lake is 153 feet, making the water 1,206 feet above the sea. This lake is crowded with low rocky islands, seldom rising above the water more than thirty feet. The timber, however, becomes larger, both on the islands and on the mainland. The lake is supposed to measure about twelve miles from northeast to southwest; and about nine miles from S.E. to N.W. The outlet is said to be at the southwest part, and to form one of the branches of the

Abatagomaw.

Notaway River, which empties into James Bay. From this lake to Chibogomou, a distance of about eight miles, the country is undulating, the highest part being about sixty feet over Abatagomaw, and thirteen feet over Chibogomou. It is rocky in some places, while ridges of brown sand are met with in others, for the first four miles. The rest of the distance presents a surface covered with large angular and rounded masses of white quartzose and granitic rocks, overgrown with from six to twelve inches of moss. Most of the wood has been burnt, and the surface is in many places covered with blueberry bushes, producing very large fruit. I may mention that on one of the portages a few bushes were found resembling the blueberry, but bearing a fruit only distinguishable from the blueberry by its color, which was that of a white currant. I regret that not having collected any specimens of this shrub, it is not possible to say whether it is of a species distinct from the blueberry.

Chibogomou. Lake Chibogomou is about twenty miles long, on the line followed; but on its south-east side it is some five miles longer. A ridge, on which stands Sorcerer's Mountain, 425 feet above the lake, projects to the southwest about twelve miles, between two arms. To the southwest of this ridge, the breadth of the lake is six or seven miles. On the northwest side, it flows, by two outlets, into another and parallel lake, the waters of which are said to fall into the Notaway River. This second lake extends about twelve miles to a point opposite the west end of Lake Chibogomou, and is from one to two miles wide. Lake Chibogomou is studded with numerous low and elongated islands, especially in its southeast extension. They are often rocky, and the shores of the lake, which are low, show either the solid rock or boulders, both covered with about a foot of moss. Towards the northeast end, and along nearly the whole of the southeast side, sandy loam prevails; and where openings in the woods are met with, a good growth of wild grass is found. Green woods surround the lake, except in the neighbourhood of Paint Mountain, where the forest has been burnt. This ridge-like mountain is situated between the two lakes, as well as between the two outlets. It rises 250 feet over the upper, and 275 feet over the lower lake.

Paint Mountain.

Lake Wakinitche. Between Chibogomo and Wakinitche, the distance is about four miles. On the portages, and around the small lakes, burnt woods prevail, and the ground is mostly rocky and barren. The highest point in the last portage to Wakinitche is 1,485 feet above the sea, and 240 feet above Lake Chibogomou, but only 45 feet above Wakinitche, the latter being 1,440 feet above the sea. Lake Wakinitche stretches north-easterly about twenty-four miles, and is from half a mile to three miles wide. On the southeast side, a considerable area has been run over by fire, while the remainder is dotted with green woods; the trees are of good size, and of the usual kinds, spruce, white birch, tamarack, and some balsam-fir. Along this side, as far as observed, the height over the lake is from 100 to 150 feet, and the soil is a sandy loam, well fitted for agricultural purposes. The northwest side and the southwest end, of this

lake are divided into bays running parallel to each other, and from one to four miles in length; these are separated by narrow rocky ridges from 100 to 250 feet high. One hill, at the southwest extremity and northwest side, is supposed to be about 400 feet high. At the narrows, about six miles to the northeast, a bare rocky escarpment extends for about four miles on the north-eastside, rising from 150 to 200 feet above the lake. Half a mile back, green woods are seen. Beyond the narrows, the shore is low, and the soil similar to that on the southeast side, except over Wakinitche Mountain, which has been described, page 294. There is another rocky hill about seven miles to the southwest of the last, of about the same height, but apparently of less extent. Looking from the top of the first of these northward to the bays of Lake Mistassini, the country is a level plain, with here and there glimpses of the long narrow bays of the lake. Wakinitche Lake empties into Abatigoush Bay by a stream of about four miles in length. In this distance, there are three portages, with a fall of fifty-nine feet, which, deducted from the height (1,440 feet) previously given for Lake Wakinitche, makes Lake Mistassini 1,381 feet above the sea.

About thirty miles of Abatigoush and Cabistachuan Bays were surveyed, to where they open out to the main lake. The probable size of Lake Mistassini has already been stated. Along its whole extent, it probably presents much the same features as in the part examined. As before mentioned, the country soon after leaving Wakinitche, is underlaid by comparatively flat limestone strata, the decomposition of which gives a fertile calcareous soil. The surface is level; in no place that I observed, rising more than thirty feet above the lake, thus rendering the region favourable for agriculture. What influence the climate may have on vegetation, I am unable to determine, and the only fact I can offer bearing upon this is that Mr. Burgess, of the Hudson's Bay Company's post on the lake, furnished us, on the 7th August, with fair-sized new potatoes, these being the only crop at present cultivated here.

The first of the two following tables gives the daily temperature recorded by Mr. J. Leitch during the exploration, and the corresponding daily temperature at Montreal, the latter having been kindly furnished by Dr. Smallwood, Director of the Meteorological Observatory at Montreal.

The second gives a catalogue of the plants collected during the expedition, which have been examined and named by George Barnston, Esq., of this city, to whom my best thanks are due.

I have the honour to be, Sir,

Your most obedient servant,

(Signed,) JAMES RICHARDSON.

MONTREAL, 20th April, 1870.

I. *Thermometric Observations during the Journey.*

Date.		Temperature.						Miles north of Montreal.	Height in feet above sea level.	Locality.	Temperature at Montreal.		
		A.M.	°	P.M.	°	P.M.	°				7.00 A.M.	2.00 P.M.	9.00 P.M.
June	24	....		... .		6.30	92	217	293	River Ashuapmouchouan ...	68·8	89·6	78·9
,,	25	8.00	75	....		....		220	420	,, ,, ...	71·4	88·1	74·2
,,	26	6.30	69	....		9.45	68	226	500	,, ,, ...	71·1	89·9	68·8
,,	27	6.30	72	....		....		230	545	,, ,, ...	67·7	89·4	73·0
,,	28	6.30	65	1.00	72	9.45	56	235	853	Chaudière Falls ,, ...	74·1	80·6	72·0
,,	29	7.00	65	1.00	80	9.40	54	242	878	,, ,, ...	64·0	79·2	70·1
,,	30	7.30	52	2.30	72	9.15	46	245	882	,, ,, ...	67·0	62·5	59·8
July	1	7.30	52	3.15	62	0.10	54	247	894	,, ,, ...	54·2	78·6	59·7
,,	2	8.00	64	1.15	70	9.20	66	252	943	,, ,, ...	58·2	77·9	69·0
,,	3	....		12.30	66	11.00	66	252	959	,, ,, ...	64·1	80·0	74·6
,,	4	7.30	66	5.30	75	9.45	64	258	975	Chief River ,, ...	65·8	87·2	72·3
,,	5	8.30	62	....		9.00	62	261	1000	,, ,, ...	64·2	80·9	71·7
,,	6	8.00	60	6.30	62	10.15	50	....	....	,, ,, ...	67·8	86·4	75·8
,,	7	9.15	58	3.30	56	9.30	60	255	1121	,, ,, ...	73·0	82·4	74·0
,,	8	7.15	66	3.30	60	11.00	42	....	....	,, ,, ...	66·0	71·0	66·8
,,	9	8.15	56	3.15	58	10.30	60	247	1184	Lake Ashuapmouchouan....	62·2	79·0	69·1
,,	10	9.15	58	1.15	68	10.15	68	....	....	Water in lake, 7.00 p.m., 60°	68·2	83.2	75·3
,,	11	7.30	56	3.30	78	9.45	60	....	....	....	68·5	89·2	77·0
,,	12	8.30	68	....		10.30	64	252	1202	Nikoubau River............	73·4	81·7	72·0
,,	13	8.00	60	....		9.45	54	255	1230	,, ...	68·2	82·4	66·1
,,	14	7.30	48	1.15	58	10 15	50	256	1251	Kettle-River Branch	65·2	78·8	68·0
,,	15	7.30	58	6.20	54	10.15	50	257	1266	Nikoubau Lake	62·0	82·4	68·3
,,	16	7.30	55	2.15	66	9.30	55	263	1278	,, ,, ...	62.0	81·7	72·1
,,	17	8.30	58	1.30	69	10.39	64	....	....	,, ,, ...	68.7	88·0	77·6
,,	18	8.30	62	2.00	66	10.15	60	....	....	,, ,, ...	74.2	92·0	77·7
,,	19	8.15	56	1.30	76	9.35	55	267	1288	,, ,, ...	70.0	90·2	75·8
,,	20	8.00	64	1.00	84	10.15	70	269½	1329	Height-of-land.	71·1	89·2	74·0
,,	21	8.15	52	1.00	66	9.45	50	270	1224	Source of River Notaway.	73·2	92·0	72·0
,,	22	7.00	51	1.00	89	10.15	70	272	1206	Lake Abatagomaw	68·7	90·3	77·2
,,	23	7.30	66	....		9.30	68	273	....	,, ,, ...	50·4	87·4	79·5
,,	24	9.15	68	2.30	66	8.40	60	....	....	,, ,, ...	74·7	96·1	74·0
,,	25	7.30	64	....		10.30	54	279	1205	Lake Abatagomaw	72·3	84·1	73.2
,,	26	7.20	60	8.30	40	10.00	32	282	1254	Between Abatagomaw and Chibogomou	71·1	87·0	75·1
,,	27	7.45	60	12.45	88	10.00	62	288	1247	Lake Chibogomou	61·2	82·0	69·1
,,	28	10.00	60	....		10.30	58	....	....	,, ,, ...	65·1	92·0	74·2
,,	29	6.35	60	....		10.15	56	295	....	,, ,, ...	69·0	72·1	64·2
,,	30	8.45	73	....		11.00	56	297	....	,, ,, ...	67·0	74·2	68·2
,,	31	11.30	76	3.00	60	10.00	60	....	....	,, ,, ...	68·0	87·7	70·1
Aug.	1	8.00	50	....		11.00	44	301	1277	,, ,, ...	70·0	87·1	74·1
,,	2	7 30	56	2.00	54	11.00	36	304	1370	Between Chibogomou and Wakinitche................	58·3	74·2	64·1
,,	3	8.00	65	... .		10.00	56	312	1440	Lake Wakinitche	57.6	77·2	69·0
,,	4	7.45	58	....		9.20	50	317	....	Lake Wakinitche	68·0	86·7	74·3
,,	5	7.30	58	12.30	76	10.00	54	330	1395	Cutlet of ,, ...	65·0	80·0	67·9
,,	6	7.00	54	....		10.00	60	333½	1381	H.B. Co's Post, Abatigoush	66·9	73·1	72·6
,,	7	9.30	67	12.00	90	10.40	58	....	....	,, ,, ..	69.7	86.4	74·2
,,	8	8.00	66	....		10.00	62	....	....	,, ,, ...	71·1	89·4	78·1
,,	9	7.00	64	2.30	80	9.50	62	....	....	,, ,, ..	74·2	85·2	76·0
,,	10	6.30	64	12.10	78	9.20	55	...	....	,, ,, ..	69·6	86·2	77·3
,,	11	8.00	74	....		11.30	52	....	....	,, ,, ..	71·1	89·4	78·0
,,	12	8.15	68	....		10.30	48	....	....	,, ,, ..	72·1	75·4	73·0
,,	13	6.45	52	....		9.30	48	308	1440	Lake Wakinitche	65·0	68·2	67·3
,,	14	9.30	48	....		9.30	54	....	.. .	,, ,, ...	62·0	78·0	66·0
,,	15	5.30	49	....		9.55	42	306	....	,, ,, ...	57·1	76·2	64·7
,,	16	7.10	58	....		9.00	52	301	1247	Lake Chibogomou	58·4	86·1	70·1
,,	17	7.30	58	....		11.00	62	297	....	,, ,, ...	65·2	82·0	72·1
,,	18	6.00	48	....		11.00	46	279	1206	Lake Abatagomaw	68·0	83·4	70·0
,,	19	5.15	56	....		9.30	73	257	1266	Lake Nikoubau	67·1	92·6	79·0

Thermometric Observations.—Continued.

Date.		Temperature.						Miles north of Montreal.	Height in feet above sea level.	Locality.	Temperature at Montreal.		
		A.M.	°	A.M.	°	A M.	°				7.00 A.M.	2.00 P.M.	9.00 P.M.
Aug.	20	10.30	57	....		8.50	49	....	....	Lake Nikoubau	71·4	89·6	08·7
,,	21	9.30	54	... .		11.00	51	....	....	,, ,, ...	60·2	76·4	66·2
,,	22	8.15	57	....		11.00	52	....	....	,, ,, ...	61·0	71·2	65·0
,,	23	8.00	55	12 noon	76	9.45	48	249	1280	Foam-Fall River	61·9	74·2	68·0
,,	24	8.30	62	....		10.15	53	243	1288	Lake Askatiche	67·4	85·0	72·6
,,	25	8.30	62	....		9.40	60	232½	1333	Foam Falls	69·4	78·2	73·0
						p. m.	°						
,,	26	8.10	44	Noon	50	10.30	32	232½	1332	Foam Falls, Foam-Fall Riv.	54·6	69·9	60·0
,,	27	8.30	50	....		10.10	60	227	1360	Lake Normandin ,, .	54·7	71·6	64·0
,,	28	10.00	00	....		9.10	58	..	....	,, ,, .	59·7	80·0	59·6
,,	29	9.00	58	....		9.00	62	225½	1480	Water-shed between Foam Falls River and Clear Water River	62·0	71·0	70·2
,,	30	8.00	53	....		10.15	50	222	1393	Clear Water Lake..........	63·0	76·3	67·0
,,	31	9.00	56	....		10.00	40	220	1340	Clear Water River	61·1	72·0	64·1
				P. M.	°								
Sept.	1	6.00	40	1.00	76	10.05	50	215	1305	Lake Pemscache............	60·2	80·2	70·0
,,	2	7.30	48	....		10.25	52	210	1289	River St. Maurice, Sandy Beach Lake..............	61·1	71·1	67·0
,,	3	10.30	62	....		10.58	58	203	....	,, ,, ,,	61·1	67·2	64·1
,,	4	9.00	56	....		9.00	54	198	....	,, ,, ,,	60·2	67·0	61·1
,,	5	8.30	48	6.00	50	10.30	47	....	....	,, ,, ,,	56·0	75·0	58·0
,,	6	6.30	45	12.00	50	10.30	31	196	1276	River St. Maurice..........	50·1	77·2	59·7
,,	7	7.00	37	....		10.00	37	195	1275	,, Kirkendatch.	53·7	77·3	64·0
,,	8	8.30	44	....		10.30	48	....	....	,, ,, .	53·2	76·7	62·2
,,	9	9.00	58	... .		10.30	54	....	....	,, ,, .	60·1	76·3	66·2
,,	10	8.30	46	....		11.00	40	....	....	,, ,, .	57·8	71·7	55·0
,,	11	9.30	50	....		9.30	32	....	....	,, ,, .	46·0	70·0	57·6
,,	12	5.30	30	4.20	72	11.15	40	....	....	,, ,, .	47·2	70·2	59·0
,,	13	8.00	60	....		10.00	58	189	1630	Hair-Cutting River.........	54·1	82·3	63·4
,,	14	7.30	40	....		9.35	52	183	1425	,, ,, ...	60·1	85·1	72·0
,,	15	7.00	50	....		9.40	44	178	1510	Hair-Cutting Lake.........	62·1	84·2	68·1
,,	16	7.30	40	....		8.00	50	167	1482	S. E. Branch, Gatineau Riv.	54·6	71·1	58·0
,,	17	8.00	40	....		9.20	48	169	1340	,, ,, .	54·6	68·5	69·1
,,	18	7.30	38	....		9.00	44	145	1079	,, ,, .	58·4	86·7	56·5
,,	19	6.00	31	6.00	50	10.00	41	132½	815	Junction of the two branches	49·4	81·1	60·0
,,	20	8.30	40	2.15	70	10.00	43	112	630	Gatineau River, Old Man River Branch	55·0	82·4	69·2
				A. M.	°								
,,	21	6.30	38	7.30	42	9.30	43	101	516	Gat. R., Hamilton's Farm.	52·2	79·9	67·3
				P. M.	°								
,,	22	6.30	42	6.00	64	9.30	54	89	511	,, River St. Jean de Terre	58·0	82·3	68·1
,,	23	8.30	57	Water in River	60	9.30	42	74	394	,, Big Eddy Portage....	64·0	82·0	60·0
,,	24	7.30	46	....		10.00	44	60	369	,, River Desert Branch .	53·4	68·1	63·1
,,	25	9.00	54	....		8.30	52	....	....	,, ,, ,, .	56·2	63·0	60·2

II. *List of Plants from North of Lake St. John.*

Date.	No.	Name of Plant.	Locality.	Miles north of Montreal.	Height above sea level.
June 15...	1	Vicia cracca......................	Lake St. John, Point Blue	212	350
„ 15...	2	Rosa blanda	„ „	„	„
„ 25...	3	Apocynum androsæmifolium.......	River Ashuapmouchuan .	230	545
„ 25...	4	Lycopodium dendroideum	„ „	„	„
„ 29...	5	Thalictrum cornuti	Chaudière Falls..	235	853
„ 29...	6	Spiræa salicifolia..................	„	„	„
„ 29...	7	Campanula rotundifolia	„	„	„
July 2...	8	Diervilla trifida	La Loche Brook	249	959
„ 2...	9	Juncus filiformis	„ „	„	„
„ 2...	10	Eleocharis palustris	„ „	„	„
„ 2...	11	Carex lenticularis	„ „	„	„
„ 2...	12	Aira cæspitosa	„ „	„	„
„ 2...	13	Eleocharis palustris................	„ „	„	„
„ 2...	14	Cornus Canadensis	„ „	„	„
„ 2...	15	Apocynum androsæmifolium	„ „	„	„
„ 2...	16	Spiræa salicifolia............... ...	„ „	„	„
„ 2...	17	Iris versicolor......................	„ „	„	„
„ 2...	18	Hieracium Canadense.............	„ „	„	„
„ 2...	19	Scirpus atrovirens	„ „	„	„
„ 2...	20	Carex oligospirum (Mich).........	„ „	„	„
„ 2...	21	Campanula rotundifolia	„ „	„	„
„ 2...	22	Cornus stolonifera..................	„ „	„	„
„ 2...	23	Spiræa salicifolia..................	„ „	„	„
„ 2...	24	Carex adusta (Booth) *...........	„ „	„	„
„ 2...	25	Achillæa millifolium	„ „	„	„
„ 2...	26	Campanula rotundifola	„ „	„	„
„ 2...	27	Epilobium angustifolium	„ „	„	„
„ 2...	28	Apocynum androsæmifolium.......	„ „	„	„
„ 2...	29	Rubus triflorus	„ „	„	„
„ 2...	30	Osmunda cinnamomea	Lake Ashuapmouchuan.	247	1,184
„ 2...	31	Spiræa salicifolia..................	„ „	„	„
„ 2...	32	Thalictrum cornuti.................	„ „	„	„
„ 2...	33	Orchis Huronensis)Lindley)	„ „	„	„
„ 11 ..	34	Avena striata	„ „	„	„
„ 11...	35	Cornus Canadensis.................	„ „	„	„
„ 11...	36	Myrica gale	„ „	„	„
„ 11...	37	Dracæna borealis (Ait)	„ „	„	„
„ 11...	38	Amelanchier Canadensis	„ „	„	„
„ 11...	39	Viburnum parvifolium	„ „	„	„
„ 11...	40	Vaccinium retinosum	„ „	„	„
„ 11...	41	Phleum pratense	„ „	„	„
„ 11...	42	Vaccinium Pennsylvanicum........	„ „	„	„
„ 11...	43	Rubus strigosus....................	„ „	„	„
„ 11...	44	Amelanchier Canadensis...........	„ „	„	„
„ 11...	45	Hypericum perforatum.............	„ „	„	„
„ 11...	46	Rubus triflorus......................	„ „	„	„
„ 11..	47	Sium angustifolium	„ „	„	„
„ 11...	48	Tofieldia glutinosa	„ „	„	„
„ 11...	49	Eleocharis palustris (var. glaucescens).........................	„ „	„	„
„ 11...	50	Lobelia Dortmanna (rare)...... ..	„ „	„	„
„ 11...	51	Kalmia angustifolia	„ „	„	„
„ 11...	52	Spiræa salicifolia..................	„ „	„	„
„ 11...	53	Amelanchier Canadensis...........	„ „	„	„
„ 11...	54	Osmunda regalis	„ „	„	„
„ 11...	55	Solidago stricta	„ „	„	„
„ 11...	56	Eupatorium purpureum	„ „	„	„
„ 11...	57	Tofieldia glutinosa	„ „	„	„
„ 11...	58	Streptopus roseus	„ „	„	„

* Hooker, Flor. Bor. Amer, vol. 2. p. 215.

List of Plants.--Continued.

Date	No.	Name of Plants.	Locality.	Miles north of Montreal.	Height above sea level.
July 11...	59	Vaccinium Pennsylvanicum	Lake Ashuapmouchuan..	247	1,184
" 18...	60	Gentiana saponaria (var. linearis) ..	Perch Lake..............	265	1,278
" 18...	61	Kalmia glauca	"	"	"
" 18...	62	Lycopodium annotinum	"	"	"
" 18...	63	Rubus triflorus....................	"	"	"
" 19...	64	Comandra livida	Branch Lake	268	"
" 19...	65	Kalmia glauca....................	"	"	"
" 19...	66	Pyrus Americana..................	"	"	"
" 19...	67	Potentilla fruticosa	"	"	"
" 19...	67½	Galium asprellum.................	"	"	"
" 19...	68	Streptopus roseus	"	"	"
" 19...	69	Comarum palustre	"	"	"
" 19...	70	Epilobium tenellum *...............	"	"	"
" 20...	71	Aster biflorus (Mich)†	Narrow Ridge Lake.....	269	1,286
" 20...	72	Spiranthes cernua	"	"	"
" 20...	73	Lobelia Kalmii	"	"	"
" 20...	74	Eriophorum vaginatum	"	"	"
" 20...	75	Senecio aureus	"	"	"
" 20...	76	Solidago stricta	"	"	"
" 20...	77	Andromeda polifolia..............	"	"	"
" 21...	78	Epilobium angustifolium	Height of Land.........	269½	1,359
" 21...	79	Andromeda calyculata	" "	"	"
" 21...	80	Potentilla Norvegica..............	" "	"	"
" 21...	81	Carex stellulata..................	" "	"	"
" 21...	82	Smilacina bifolia................	" "	"	"
" 21...	83	Rubus Chamæmorus	" "	"	"
" 21...	83½	Calamagrostis Canadensis	" "	"	"
" 21...	84	Agrostis scabra.	" "	"	"
" 21...	85	Salix prinoides	" "	"	"
" 25...	86	Aralia hispida....................	Lake Abatagomaw	279	1,206
" 25...	87	Vaccinium Pennsylvaninum	" "	"	"
July 25...	88	Juncus pelocarpus................	" "	279	1,206
" ...	89	Melampyrum sylvaticum	" "	"	"
" ...	90	Triglochlin maritimum	" "	"	"
" ...	91	Tofielda glutinosa................	" "	"	"
" ...	92	Platanthera psycodés..............	" " .	"	"
" ...	93	Lysimachia stricta	" "	"	"
July 29...	94	Sium lineare......................	Lake Chibogomou	301	1,247
" ...	95	Corydalis glauca	" "	"	"
" ...	96	Solidago Canadensis..............	" "	"	"
" ...	97	Antennaria margaritacea	" "	"	"
" ...	98	Potentilla Norvegica	" "	"	"
" ...	99	Scutellaria galericulata	" "	"	"
" ...	100	Scirpus lacustris	" "	"	"
" ...	101	Anemone Pennsylvanica	" "	"	"
" ...	102	Lycopus Virginianus	" "	"	"
" ...	103	Carex Houghtonii (Torrey)	" "	"	"
" ...	104	Solidago umbellata................	" "	"	"
" ...	105	Viburnum parviflorum	" "	"	"
" ...	106	Cornus stolonifera.................	" "	"	"
" ...	107	Calamagrostis Canadensis..........	" "	"	"
July 30...	108	Melampyrum sylvaticum	Top of Sorcerer's Mt....	"	1,672
" ...	109	Œnothera pumila	" "	"	"
" ..	110	Epilobium palustre	" "	"	"
" ...	111	Cornus Canadensis	" "	"	"
" ...	112	Abies ?............................	" "	"	"
" ...	113	Comandra livida	" "	"	"
" ...	114	Smilacina bifolia....	" "	"	"
" ...	115	Pyrola secunda...................	" "	"	"
" ...	116	Polypodium dryopteris	" "	"	"

* Rafin.; perhaps the same as E. oliganthum; see Hooker, Flor. Bor. Amer, vol. 1. pages 207, 209.

† This Aster is in the division named Callistrum by Torrey, and appears here, as it were, at the entry into the Labrador country.

II. *List of Plants from North of Lake St. John.*

Date.	No.	Name of Plant.	Locality.	Miles north of Montreal.	Height above sea level.
June 15...	1	Vicia cracca	Lake St. John, Point Blue	212	350
„ 15...	2	Rosa blanda	„ „	„	„
„ 25...	3	Apocynum androsæmifolium	River Ashuapmouchuan	230	545
„ 25...	4	Lycopodium dendroideum	„ „	„	„
„ 29...	5	Thalictrum cornuti	Chaudière Falls.. "	235	853
„ 29...	6	Spiræa salicifolia	„	„	„
„ 29...	7	Campanula rotundifolia	„	„	„
July 2...	8	Diervilla trifida	La Loche Brook	249	959
„ 2...	9	Juncus filiformis	„ „	„	„
„ 2...	10	Eleocharis palustris	„ „	„	„
„ 2...	11	Carex lenticularis	„ „	„	„
„ 2...	12	Aira cæspitosa	„ „	„	„
„ 2...	13	Eleocharis palustris	„ „	„	„
„ 2...	14	Cornus Canadensis	„ „	„	„
„ 2...	15	Apocynum androsæmifolium	„ „	„	„
„ 2...	16	Spiræa salicifolia	„ „	„	„
„ 2...	17	Iris versicolor	„ „	„	„
„ 2...	18	Hieracium Canadense	„ „	„	„
„ 2...	19	Scirpus atrovirens	„ „	„	„
„ 2...	20	Carex oligospirum (Mich)	„ „	„	„
„ 2...	21	Campanula rotundifolia	„ „	„	„
„ 2...	22	Cornus stolonifera	„ „	„	„
„ 2...	23	Spiræa salicifolia	„ „	„	„
„ 2...	24	Carex adusta (Booth) *	„ „	„	„
„ 2...	25	Achillæa millifolium	„ „	„	„
„ 2...	26	Campanula rotundifola	„ „	„	„
„ 2...	27	Epilobium angustifolium	„ „	„	„
„ 2...	28	Apocynum androsæmifolium	„ „	„	„
„ 2...	29	Rubus triflorus	„ „	„	„
„ 2...	30	Osmunda cinnamomea	Lake Ashuapmouchuan.	247	1,184
„ 2...	31	Spiræa salicifolia	„ „	„	„
„ 2...	32	Thalictrum cornuti	„ „	„	„
„ 2...	33	Orchis Huronensis)Lindley)	„ „	„	„
„ 11...	34	Avena striata	„ „	„	„
„ 11...	35	Cornus Canadensis	„ „	„	„
„ 11...	36	Myrica gale	„ „	„	„
„ 11...	37	Dracæna borealis (Ait)	„ „	„	„
„ 11...	38	Amelanchier Canadensis	„ „	„	„
„ 11...	39	Viburnum parvifolium	„ „	„	„
„ 11...	40	Vaccinium retinosum	„ „	„	„
„ 11...	41	Phleum pratense	„ „	„	„
„ 11...	42	Vaccinium Pennsylvanicum	„ „	„	„
„ 11...	43	Rubus strigosus	„ „	„	„
„ 11...	44	Amelanchier Canadensis	„ „	„	„
„ 11...	45	Hypericum perforatum	„ „	„	„
„ 11...	46	Rubus triflorus	„ „	„	„
„ 11...	47	Sium angustifolium	„ „	„	„
„ 11...	48	Tofieldia glutinosa	„ „	„	„
„ 11...	49	Eleocharis palustris (var. glaucescens)	„ „	„	„
„ 11...	50	Lobelia Dortmanna (rare)	„ „	„	„
„ 11...	51	Kalmia angustifolia	„ „	„	„
„ 11...	52	Spiræa salicifolia	„ „	„	„
„ 11...	53	Amelanchier Canadensis	„ „	„	„
„ 11...	54	Osmunda regalis	„ „	„	„
„ 11...	55	Solidago stricta	„ „	„	„
„ 11...	56	Eupatorium purpureum	„ „	„	„
„ 11...	57	Tofieldia glutinosa	„ „	„	„
„ 11...	58	Streptopus roseus	„ „	„	„

* Hooker, Flor. Bor. Amer, vol. 2. p. 215.

List of Plants.—Continued.

Date	No.	Name of Plants.	Locality.	Miles north of Montreal.	Height above sea level.
July 11...	59	Vaccinium Pennsylvanicum	Lake Ashuapmouchuan..	247	1,184
„ 18...	60	Gentiana saponaria (var. linearis) ..	Perch Lake............	265	1,278
„ 18...	61	Kalmia glauca	„	„	„
„ 18...	62	Lycopodium annotinum	„	„	„
„ 18...	63	Rubus triflorus..................	„	„	„
„ 19...	64	Comandra livida	Branch Lake	268	„
„ 19...	65	Kalmia glauca...................	„	„	„
„ 19...	66	Pyrus Americana.................	„	„	„
„ 19...	67	Potentilla fruticosa	„	„	„
„ 19...	67½	Galium asprellum.................	„	„	„
„ 19...	68	Streptopus roseus	„	„	„
„ 19...	69	Comarum palustre	„	„	„
„ 19...	70	Epilobium tenellum *.............	„	„	„
„ 20...	71	Aster biflorus (Mich)†	Narrow Ridge Lake.....	269	1,286
„ 20...	72	Spiranthes cernua	„	„	„
„ 20...	73	Lobelia Kalmii	„	„	„
„ 20...	74	Eriophorum vaginatum	„	„	„
„ 20...	75	Senecio aureus	„	„	„
„ 20...	76	Solidago stricta	„	„	„
„ 20...	77	Andromeda polifolia..............	„	„	„
„ 21...	78	Epilobium angustifolium	Height of Land.........	269½	1,359
„ 21...	79	Andromeda calyculata	„ „	„	„
„ 21...	80	Potentilla Norvegica.............	„ „	„	„
„ 21...	81	Carex stellulata..................	„ „	„	„
„ 21...	82	Smilacina bifolia................	„ „	„	„
„ 21...	83	Rubus Chamæmorus	„ „	„	„
„ 21...	83½	Calamagrostis Canadensis	„ „	„	„
„ 21...	84	Agrostis scabra.	„ „	„	„
„ 21...	85	Salix prinoides	„ „	„	„
„ 25...	86	Aralia hispida	Lake Abatagomaw	279	1,206
„ 25...	87	Vaccinium Pennsylvaninum	„ „	„	„
July 25...	88	Juncus pelocarpus................	„ „	279	1,206
„ ...	89	Melampyrum sylvaticum	„ „	„	„
„ ...	90	Triglochlin maritimum	„ „	„	„
„ ...	91	Tofielda glutinosa................	„ „	„	„
„ ...	92	Platanthera psycodés..............	„ „ .	„	„
„ ...	93	Lysimachia stricta	„ „	„	„
July 29...	94	Sium lineare.....................	Lake Chibogomou	301	1,247
„ ...	95	Corydalis glauca	„ „	„	„
„ ...	96	Solidago Canadensis..............	„ „	„	„
„ ...	97	Antennaria margaritacea	„ „	„	„
„ ...	98	Potentilla Norvegica	„ „	„	„
„ ...	99	Scutellaria galericulata	„ „	„	„
„ ...	100	Scirpus lacustris	„ „	„	„
„ ...	101	Anemone Pennsylvanica	„ „	„	„
„ ...	102	Lycopus Virginianus	„ „	„	„
„ ...	103	Carex Houghtonii (Torrey)	„ „	„	„
„ ...	104	Solidago umbellata...............	„ „	„	„
„ ...	105	Viburnum parviflorum	„ „	„	„
„ ...	106	Cornus stolonifera................	„ „	„	„
„ ...	107	Calamagrostis Canadensis..........	„ „	„	„
July 30...	108	Melampyrum sylvaticum	Top of Sorcerer's Mt...	„	1,672
„ ...	109	Œnothera pumila	„ „	„	„
„ ...	110	Epilobium palustre	„ „	„	„
„ ...	111	Cornus Canadensis	„ „	„	„
„ ...	112	Abies ?..........................	„ „	„	„
„ ...	113	Comandra livida	„ „	„	„
„ ...	114	Smilacina bifolia....	„ „	„	„
„ ...	115	Pyrola secunda..................	„ „	„	„
„ ...	116	Polypodium dryopteris	„ „	„	„

* Rafin.; perhaps the same as E. oliganthum; see Hooker, Flor. Bor. Amer, vol. 1. pages 207, 209.

† This Aster is in the division named Callistrum by Torrey, and appears here, as it were, at the entry into the Labrador country.

List of Plants.—Continued.

Date.	No.	Names of Plants.	Locality.	Miles north of Montreal.	Height above sea level.
Aug. 6...	117	Mentha borealis...............	Abatigoush............	333½	1,381
,, ...	118	Polypodium dryopteris............	Bay Lake, Mistassini...	,,	,,
,, ...	119	Scutellaria galericulata............	,, ,, ..	,,	,,
,, ...	120	Dracæna borealis	,, ,, ..	,,	,,
,, ...	121	Comandra livida	,, ,, ..	,,	,,
,, ...	122	Rhinanthus crista-galli	,, ,, ..	,,	,,
,, ...	123	Cornus stolonifera................	,, ,, ..	,,	,,
,, ...	124	Linnæa borealis..................	,, ,, ..	,,	,,
,, ...	125	Osmunda interrupta (Mich).......	,, ,, ..	,,	,,
,, ...	126	Aster sagittifolius................	,, ,, ..	,,	,,
,, ...	127	Solidago stricta..................	,, ,, ..	,,	,,
,, ...	128	Cirsium muticum	,, ,, ..	,,	,,
,, ...	129	Botrychium Virginianum..........	,, ,, ..	,,	,,
,, ...	130	Luzula melanocarpa..............	,, ,, ..	,,	,,
,, ...	131	Triticum repens..................	,, ,, ..	,,	,,
,, ...	132	Vaccinium vitis-idæa..............	,, ,, ..	,,	,,
,, ...	133	Rubus triflorus....................	,, ,, ..	,,	,,
,, ...	134	Streptopus roseus	Abatigoush.............	,,	1,381
,, ...	135	Eriocaulon septangulare	Lake Ashuapmouchuan..	,,	1,184

ABSTRACT OF A REPORT

ON THE

GEOLOGY

OF

PARTS OF THE COUNTIES OF

FRONTENAC, LEEDS AND LANARK,

(ONTARIO),

BY

MR. HENRY G. VENNOR, F.G.S.,

ADDRESSED TO

A. R. C. SELWYN, ESQ., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, May 1st, 1871.

SIR,—In your Summary Report, dated May 2nd, 1870, on page 5, you have already alluded to my observations for 1869. It was there stated that these had been chiefly confined to portions of the counties of Addington and Frontenac, and had embraced an area of about 1,150 square miles, in which the distribution of the rocks composing the divisions A, B and C, adopted in the Report of Progress for 1866–69, page 144, had been determined and mapped.

It will be remembered, as stated by you in the preface to the volume of 1866-69, that although my report therein contained was dated May 1st, 1869, there had subsequently been incorporated with it such a portion of the results obtained by me during the summer of that year, as was required to make more complete the geological description of the region then under examination. The remaining results of the season of 1869, together with those of 1870 in the same section of country, are embodied in the following abstract, which I now beg to lay before you.

Area examined. The area examined during last season is partly included in that described in my previous report, being portions of the eastern and southern sides of Frontenac County, embracing the townships of Olden, Oso, Bedford and Loughboro. It also includes a part of the county of Lanark, viz., the townships of South Sherbrooke, Bathurst, Dalhousie and Levant. The

work was brought to an abrupt termination in these last-named townships, early in September, by the bush-fires, which caused much destruction throughout that district.

GEOLOGICAL DESCRIPTION.

Three divisions.

The rocks met with in this region, may be included under the three divisions already alluded to, which are as follows, numbered in ascending order :—

1. A.—Gneiss, often syenitic, with crystalline limestones and magnetic iron ores. (Laurentian).
2. B.—Diorites and diabases, passing into chlorite schists, often epidotic, with steatite, and with magnetic and hematitic iron ores. (probably Huronian.)
3. C.—Dolomites, argillaceous calcareous and micaceous schists. with gneisses.

Relations.

The relations of these three groups of rocks, as determined in 1868, have been fully supported by the observations made in 1870. The dolomites, and schists of division C lie unconformably upon the gneiss and crystalline limestones of A, while the true position of the diorites and chloritic schists of division B, appears to be at the base of C; where, however, they are not unfrequently wanting, suggesting a probable unconformity of these both with the upper and lower divisions.

Division A.; Laurentian.

Gneisses.

The rocks of this division compose the greater part of the country examined in 1870. The granitoid gneisses are made up of a flesh-colored feldspar with gray quartz, greenish hornblende, and a very little mica, and are much cut up by granitic veins. Their strike is very uniform to the north and northeast (magnetic), with an almost invariable dip to the eastward, at high angles. Bands of crystalline limestone occur among these gneisses, and with them are found deposits of magnetic iron ore in in the townships of Bedford and South Sherbrooke, and North and South Crosby. The *Eozoon Canadense*, found in North Burgess, also occurs in these crystalline limestones. Among the granitic gneisses there occur, in several localities, great areas of fine-grained granitic rocks, consisting of little else than red orthoclase and white quartz, without any apparent marks of stratification. It is not certain whether these are to be looked upon as eruptive or as indigenous rocks. These are largely developed in the townships of Anglesea, Effingham and Abinger.

Limestones.

Divisions B and C.

The examinations of this year have shewn that there exists in Kaladar and Barrie—apparently overlying the diorites of division B,—an additional thickness of greenish dioritic schists, with quartzose conglomerates at their summit; thus raising the thickness of this division to nearly 10,000 feet, or more than double the volume given in my Report of 1868. An additional fact ascertained, is that the steatites of Elzivir, described in the *Geology of Canada*, page 469, belong properly to the rocks of this division, and not, as formerly supposed, to the Laurentian. Dr. Hunt has called attention to the fact that rutile occurs crystallized in veins with scaly chlorite among these rocks in Marmora; the specimens resembling those found in chloritic schists in Sutton, Quebec, and in Windsor, Massachusetts.

Greenish schists.

Steatite; rutile.

In my explorations in 1869 and 1870, the rocks of divisions B and C, the character of which had previously been studied in the great area occupied by them in the townships of Madoc, Marmora, Tudor, and Lake, were followed for a considerable distance in another area or basin, apparently connected at its southwest extremity, in Elzivir, with the one just noticed. This latter basin has been traced to the northeastward through the village of Flinton in Kaladar, and thence through Barrie, Clarendon, and Palmerston, into Darling, a distance of about sixty miles. It is not more than two miles in breadth in Elzivir and Kaladar, but widens very much to the northeastward, and is limited on either side by a more elevated region of coarse gneissic and granitoid rocks. The typical greenish dioritic and chloritic rocks of division B are largely developed through Elzivir, Kaladar, the southwestern part of Barrie, and parts of Levant and Darling, and are always either vertical in attitude, as in Elzivir and Kalador, or dipping at angles of 45° and upwards, as in Levant and Darling. For a considerable interval along the course of this basin, in the townships of Palmerston, Clarendon, and the greater part of Barrie, the greenish rocks which characterize the division B appear to be absent. The basin, here much expanded, is occupied by the dolomites, with argillaceous, micaceous and calcareous schists, and gneisses of division C, which are seen along the course of the Mississippi, in a nearly horizontal attitude, through Barrie and Clarendon, as far as the edge of Palmerston; through which township they have not yet been traced. They are, however, again met with in Levant and Darling, in both of which townships they are seen in contact with the chloritic schists of B, without any apparent unconformity.

Basin of the higher rocks.

Chloritic schists, of B.

Limestones and schists of C.

To the westward of these rocks, in Levant, and separated from them by a ridge of red granitoid gneiss, appears a series of mica-schists, which are largely developed both to the northward and westward, in the adjacent townships of Blythfield and Palmerston; where they are found often nearly horizontal, or with dips of from 15° to 20°, and in one instance only were

Mica-schists.

observed to have an angle of 45° ; the dips being sometimes to the eastward, and at other times to the westward. These mica-schists, which are generally friable and disintegrating, are frequently very quartzose, and sometimes garnetiferous. They are often made up in great part of large distinct laminæ of silvery white mica, but are sometimes finer grained and ferruginous. With them are associated beds of a greyish-white fine-grained friable gneiss, and also of a black hornblende-rock, sometimes micaceous, and occasionally, by an admixture of feldspar, passing into a diorite. Interstratified with these schists, are crumbling granular limestones in beds of a few feet in thickness.

Gneiss and hornblende-rock.

Geological resemblances.

These rocks, according to Dr. Hunt, have close lithological resemblances with those of the White Mountain series, in New England, and with the mica-schists which are found both to the north and south of Lake Superior, which he has compared with the same series. These mica-schists of Levant are very similar to portions of the rocks of division C, as displayed in Madoc and Tudor, and may not improbably be found to form a part of the same division. They appear to belong to the western portion of the basin which has just been described, and like the schists of division C in Barrie and Clarendon are, as we have seen, slightly inclined, or nearly horizontal in attitude.

Economic Materials.

The economic materials met with last season are the ores of iron, copper and lead, phosphate of lime or apatite, mica, marble and whet-stones.

Magnetic iron ores.

Iron.—In my previous report, several deposits of iron ore were described in the rocks of division B, but this formation has afforded no iron ores in the region examined during the past season. Those met with in the region now under description are, with one exception, of the magnetic species, and appear to be included in division A, with the limestones of which they are closely associated. One of these in South Crosby, known as the Chaffey mine, is described in the *Geology of Canada*, page 674, and an analysis of the ore by Dr. Hunt, will also be found in the Reports of Progress for 1866–69, page 257. This, with another opening on an adjoining lot, to the northeastward, known as the Yankee mine, were the only ones worked in the district here described, at the time of my explorations last summer.

South Crosby.

Bedford.

In addition to the localities of iron ore mentioned in the Geology of Canada as occuring in Bedford, there is one on which an opening known as the Howse Iron mine, has been made on lot four of the first concession of this township, where a bed of solid magnetic ore has been uncovered for about twenty-five yards across the strike. Fifty tons of this were mined in 1869, for shipment to Charlotte, N.Y., and found of good quality ; and during 1870, one hundred tons were mined, and drawn to the village of Westport on the Rideau, for shipment. Continuing on the northeastward strike of the Howse iron bed, we find magnetic ore again in some

quantity on lot six of the third, and again on lot eight of the fourth concession of this township. The last two localities were alluded to by Sir William E. Logan, in a note to the Report for 1858, page 48, where it was conjectured that they would continue to one noted by Mr. A. Murray, in his Report for 1852-53, on lot twenty-one in the ninth concession of Bedford. This supposition, I was enabled last season (1870) to verify, having traced a zone of iron-bearing rock from the Howse mine to lots twenty and twenty-one in the ninth concession of the same township of Bedford, and still further again northeastward into North Crosby, near a small lake known as Spectacle lake in lot nineteen of the eighth concession of this last township; in all a distance of fifteen miles. The magnetic ore on lot twenty-seven of the fourth concession, North Crosby, the property of the Hon. G. W. Allan, seems to me to be a most valuable deposit. Its connection with the Bedford openings has not yet been clearly made out, but it would appear to form the first of another series of similar deposits stretching northeasterly through South Sherbrooke and Bathurst. The ore is a fine crystalline magnetite, and as appears from Dr. Hunt's analysis (Report of Progress for 1866-69, page 258) is of great purity. During the autumn of the year 1858, Mr. Allan caused explorations to be made in this locality, and about 100 tons of ore, were raised, but the untimely death of the miner in charge caused the work to be abandoned. The openings however showed the existence of a large amount of ore, apparently belonging to two or more beds, and the prospects for its further development seem to be most favorable. **North Crosby.**

The openings seen in South Sherbrooke were the Bygrove mine on lot three of the first, and the Fournier mine on lot fourteen of the same concession, both being in the same geological horizon. These, however, were not being worked at the time of my visit. The former had been opened during 1869, by Mr. George Oliver of Perth, who mined about one hundred and fifty tons of a very fair quality of magnetic ore. The Fournier mine is situated a few chains to the northwestward of Mr. Allan's mine in North Crosby, and it would appear to belong to a parallel bed or belt of considerable size. The iron ores formerly worked on the seventeenth, eighteenth, and nineteenth lots, in the third concession of South Sherbrooke, (Geology of Canada, page 674) bordering on Christie's or Myers's lake, belong to another and apparently a distinct horizon. The last deposit of magnetic iron noted was on the tenth and eleventh lots in the eighth concession of Bathurst, where it had been worked to some extent by a Perth company. On these last mentioned lots, the magnetic ore is much mixed with a fine crystalline green apatite or phosphate of lime; but I noticed one bed, about three feet in thickness, apparently free from this impurity. In a future report I shall endeavour to describe more in detail the characters and geological positions of these various iron ore beds. Specimens of the different ores have been collected and analyses of them will appear in a future report. **South Sherbrooke.** **Bathurst.**

Hematitic ore. Dalhousie.

A. valuable deposit of hematitic ore is at present mined on the east half of lot one in the fourth concession of Dalhousie, which is owned by Mr. Alex. Cowan and others, and was first opened in 1866, since which time it has been more or less worked. It is a bed averaging nine feet in width, in a band of crystalline limestone, and dips at an angle of 60° to the southeastward. Six shafts about eight by ten feet, and varying from twenty-two to fifty feet in depth, have been sunk, and up to the present time (April 1st, 1871,) the bed has been stoped to the extent of 56,400 cubic feet, and about 3,125 tons of ore extracted. The ore is drawn twelve miles to Perth, whence it is sent by rail to Brockville. and thence shipped to Cleveland, Ohio.

Copper ore.

Copper occurs in the calc-schists of Levant, as already mentioned, on the property of Mr. Benjamin Hutchins of Montreal. From two lots a considerable amount of the yellow sulphuret of copper has been raised in years past, but no work was going on at the time of my examination. The results of some fire-assays which I have made of several quartz veins which traverse ferruginous dolomites in the vicinity of the copper-ore, showed the presence of traces of gcld.

Gold.

Lead.

Lead.—Several lead-bearing veins in Bedford were opened many years since, and are described in the *Geology of Canada*, page 687. The Frontenac mine, which is in Loughboro, (Report of Progres, 1866-69, page 164) was the only one worked in this region in 1870, though some veins in this township, apparently in the strike of the Frontenac vein, seem to be of promise. All of these occur in the rocks of division A.

Frontenac mine.

The shaft at the Frontenac mine in May, 1870, was eighty feet deep, on a vein averaging from ten to twenty feet in width. Work was carried on more or less actively up to to the middle of July, when difficulties arose which led the company to suspend operations for the remainder of the season. There had been raised up to the autumn of 1870, from four to five hundred tons of dressed ore, but it had neither been smelted nor sent out of the province, owing to the high price of freight, and the heavy export-duties to the United States. This same vein has been opened, to a slight extent, about three-quarters of a mile to the westward of the shaft, and in an adjoining lot. Here the vein was found to be eleven feet six inches wide, and had a combed structure. I am of the opinion that some improvements in the dressing machinery, and a good pump, would enabie the Frontenac lead-mine to be worked with profit. In the township of Storrington, near the shore of Dog Lake, about two miles from the village of Battersea, another well-defined lead-vein, has been uncovered, and would appear to be in the strike of one of the lodes belonging to the Frontenac company, and is said will shortly be opened by an American company.

Phosphate of Lime.—The phosphate of lime or apatite which is found in North and South Burgess and South Elmsley is well known, and has been described by Dr. Hunt in the *Geology of Canada*, page 761, and in the

Report for 1863-66, pages 224-229. Mr. Gordon Broome, who spent some time in examining the region last summer, has made many notes relating to these deposits, which will be found on the following pages. I have also found this mineral, for the first time, in North Crosby, Bedford, and Loughboro' townships, where it would appear to characterize a particular geological horizon. In Bedford a phosphate-bearing band was traced from Opinicon Lake, along the southern shore of Devil Lake, nearly to the northeast end of Birch lake on the third lot of the seventh concession of this township. At Opinicon Lake, a deposit of apatite occurs on lot one in the seventeenth concession of Bedford, and some seventy-five tons have been raised, of which samples were sent by the proprietors to the office of the Geological Survey. This deposit however, has yet to be examined. **Phosphate of lime.**

Marble.—The crystalline limestones and dolomites of this region have been mentioned in the *Geology of Canada*, pages 822-823, as yielding, in several localities, varieties of marble. Those found in Elzivir, Madoc, Marmora and Barrie are especially noticed. Of these the limestones of Elzivir, and the southern portions of Madoc are probably Laurentian; but the dolomites of the greater part of this region are supposed to belong to division C. In this division are included the fine-grained white, pink and dove-grey marbles of Mazinaw Lake in Barrie, referred to in the above volume. Last year a dolomite, supposed to be a continuation of that just mentioned, was met with a few miles to the north-eastward of Mississagagon Lake, in the same township, where it has afforded small blocks of a pure, fine-grained white and pink marble, apparently of superior quality for ornamental purposes. **Marble.**

Whetstones.—The whetstones of Madoc are noticed in the *Geology of Canada*, page 809, and in the last Report of Progress, 1868-69, page 157; none, however, are now manufactured in this region. Mention may also be made of those noticed by Mr. Murray, in his Report of 1852-53, as occurring in the township of Kennebec, south of Cross Lake. They are, however, coarser in texture than those of Madoc, and inferior in quality. **Whetstones.**

I have the honor to be, Sir,

Your obedient servant,

HENRY G. VENNOR.

NOTES

BY

MR. GORDON BROOME, F.G.S.,

ON THE

PHOSPHATE OF LIME AND MICA

FOUND IN

NORTH AND SOUTH BURGESS,

AND

NORTH ELMSLEY,

(ONTARIO).

The deposits of these minerals in this region have already been described by Dr. Hunt in the Geology of Canada, pages 460, 461 and 761; and again in the Report for 1863-66, pages 202—204 and 224—229. Recent explorations have, however, further developed these deposits, and Mr. Gordon Broome having collected many facts respecting them during the summer of 1870, these have been arranged from his note-book by Mr. H. G. Vennor.

Apatite.

Phosphate of lime.

The numerous veins of apatite and mica which occur in the fifth and sixth ranges of North Burgess are described with detail in the Report for 1863-66, pages 224 and 225, as vertical, and cutting, transversely to the strike, massive gneissic, micaceous and pyroxenic rocks, which dip to the south-eastward at high angles. The veins contain crystalline apatite (phosphate of lime) and phlogopite (magnesian mica) often in a gangue of crystalline carbonate of lime, sometimes associated with pyroxene, wollastonite, orthoclase, quartz and sulphate of barytes. The veins on lot four of the fifth range were worked to some extent, three years since, by the Rideau Mining Company, and are thus enumerated by Mr. Broome; the strike of the veins being north west, and their attitude vertical. Some of them have been traced for a distance of a quarter of a mile.

North Burgess

No. 1. This really consist of two veins of apatite, one of eighteen and one

of twenty four inches, separated by four and a half feet of gneiss. The apatite of the latter vein encloses large crystals of dark colored mica. This locality was worked as a single vein, at a distance of only twelve feet from Rideau Lake, and below the level of the water; which was kept out by puddling with clay. Following these, is a series of veins, the distance of each of which to the southwest of that preceding it, and the thickness, are as follows:— Series of veins

	Interval.	Thickness.
No. 2	16 feet	10 inches.
,, 3	11 ,,	3 ,,
,, 4	4 ,,	18 ,,
,, 5	very near	18 ,,
,, 6	16 feet	3 ,,
,, 7	5 ,,	3 ,,
,, 8	27 ,,	14 ,,
,, 9	30 ,,	(with pyroxene.)
,, 10	18 ,,	5 inches.
,, 11	17 ,,	1½ ,,
,, 12	10½ ,,	small string.
,, 13	18 ,,	,,
,, 14	15 ,,	8 to 24 inches.
,, 15	9 ,,	24 inches (with mica).
,, 16	24 ,,	irregular.

A second series of veins, also on lot four of the fifth range of North Burgess, was as follows:— Second series of veins:

No. 1. This is a confused vein of mica and apatite.

No. 2. This, which is fifteen feet from the last, consisted of eighteen inches of solid apatite, and nine inches of apatite mixed with mica. The latter had been mined, and about 400 pounds of the mica sold for stove-fronts, etc. This vein, which runs like the others, inclines 15° from the vertical.

No. 3. This, which is twenty-four feet from the last, is known as the Crystal vein, and is an extremely irregular and large vein composed of crystalline pink-colored carbonate of lime filled with crystals of apatite of various sizes, some weighing several hundred pounds, and others very minute. The crystals are found in the loose soil above, formed by the decomposition of the carbonate of lime; and also in cavities in many parts of the vein. The main vein, which cannot be less than fifteen feet wide, includes smaller veins or bands, with mica, affording fine crystals of this mineral, which are brownish in color. The gangue of these mica-bands is often pyroxenic, and their course is very irregular. The walls of the main vein are coated with a layer of mica. The crystals of apatite are extremely brittle, and, as already mentioned, often of great size. These frequently enclose smaller apatite crystals, and sometimes crystals of mica; while the mica occasionally contains crystals of apatite and of calcite. In the wall of this great vein

Crystal vein.

Mica.

were to be seen two beautiful crystals of apatite, as large as a man's thigh, and weighing not less than half a ton. On lot five of the fifth range, one quarter of a mile further, the whole surface of the ground is thickly strewed with boulders of rock containing crystals of apatite about the size of a pin's head.

Cave in apatite vein.

On lot eight of the fifth range, near the line of lot seven, there is a small cave, in which appears to be a calcareous vein having the characters of the Crystal vein already described. It was examined for about forty yards, but extends much further though almost inaccessible. The floor and roof are clayey, and the whole interior is thickly studded with very brittle crystals of apatite, apparently exposed by the solution of the carbonate of lime. The rocks on this lot dip at an angle of 40° to the south-east; while the direction of the cave, and consequently of the vein which it represents, is nearly north and south.

Mining apatite

On lots nine and ten of the same range much apatite or phosphate of lime has been extracted by the Rideau Mining Company, the number of exposures counted being no less than eighty. A good deal of it was shipped to Germany, from Noble's Bay, and ninety tons of second quality, valued at six to seven dollars per ton, still lie upon the wharf. †

Red apatite.

Near Noble's house, and not far from the lake, is a vein of apatite in limestone, running nearly east and west, with a dip of from 75–80° to the north. Eighty yards from this last, on the ninth lot, near the line of tenth, is a second vein, with the same strike, which widens out in one part to a large bunch of pure red apatite. On lot ten of the fifth range occurs a bluish turquoise-like variety of this mineral. One of these veins strikes N.N.E. and S.S.E. About 250 yards from the Rideau Lake, between lots nine and ten, a vein from four to six feet wide, with a dip to the northward, has been uncovered over sixty feet in length, It is composed of pure apatite, with here and there a little calcareous spar.

On lots nine and ten crystals of quartz are sometimes found coating the apatite, which is also found imbedded in the quartz crystals. Calcareous spar of the dog-tooth variety also occurs in a similar manner. One of the most productive localities in the tenth lot is formed of alternating bands of apatite and crystalline calcareous spar, almost horizontally arranged. This vein has yielded largely, and there is a good water-power near by, which might be readily applied to a super-phosphate factory. Two hundred yards from this last locality an almost square mass of apatite, eleven feet by thirteen

† Classification of the phosphate for commerce :—

Firsts....................................	75–90%	of tribasic phosphate.
Seconds.........	65–75%	,, ,,
Thirds................................	50–60%	,, ,,

The price for "firsts" containing from 85 % and upwards, is 25 cents per unit. Even in the best times "seconds" will hardly pay to export.

feet, has been extracted, of a pure quality, wholly without mica, and of a peculiar granular texture.

North Burgess.

On Donnelly's lot, number sixteen in the fifth range of North Burgess, are several openings. Pit No. 1 is 150 yards north-east of the house, and affords large crystals of apatite with mica, in strings in a pink carbonate of lime, with pyroxene. Pit No. 2, fifty yards further, shews apatite in carbonate of lime; and fifteen yards from the last, at pit No. 3, is a vein of apatite running N. N. W., and dipping eastward at $< 75°–80°$. Its width is from four to six feet, and it has yielded about forty tons of apatite. This vein occurs in gneiss, near which is a coarse-grained crystalline limestone. Forty yards to the northwest of the last is a fourth pit. Here is an irregular vein, shewing the same strike as before, cutting a quartzose gneiss, and having in one place a breadth of nine feet of nearly pure apatite. In another part of the excavation it was three and a half feet in breadth, and separated by three feet of gneiss from a smaller vein of six inches, on the south-west side. About fifteen tons of apatite have been raised from this opening. On Quinn's lot, the eighteenth of the fifth range of North Burgess, several veins from three to four feet wide are found, containing crystalline blue and red apatite. Their course is N.N.E., coinciding with the strike of the gneiss.

Apatite has also been found on lots nineteen, twenty and twenty-one of the same range; and in the sixth range, on lots eighteen, nineteen and twenty. On the last but one named is a vertical vein of apatite, associated with mica and quartz, and varying in breadth from one and a half to four feet. Its strike is W.N.W., in a close-grained hornblendic gneiss, dipping S.E. $< 65°$. It has been mined to a depth of forty feet by means of two shafts, and nearly 200 tons of apatite extracted—all "firsts." Of this 110 tons were shipped by the Rideau Canal, and eighty-five tons sent to Perth. Some of this was sold in Liverpool for £4 10s. stg. per ton, in 1867.

Cowan's mine.

On the west half of lots eleven and twelve of the seventh range of North Burgess, apatite is now being worked to supply Mr. Cowan's factory at Brockville. Numerous exposures occur here, the best of which may be mentioned. A vein is met with on twelve, (Byrne's lot,) with a dip of from 60° to 80°, and a strike to the W.N.W. It is composed of red and green apatite, with mica, and occasionally with carbonate of lime, and is probably the same vein which was intersected a short distance from the present workings, by a shaft and level now for some time abandoned. The width of the vein varies from four to five feet, increasing in places to seven or eight feet, but it appears to lessen at the bottom of the excavation. The level is at a depth of thirty feet, and extends about twenty-eight feet. Much oxyd of iron is found with some of the apatite in this locality, which, in the deeper workings, is replaced by pyrites. A large shed has here been erected for hand-picking and sorting the apatite, as well as for winter storage. The mineral is carted to Perth, a distance of ten miles, and is thence taken by railway to Brockville.

Power's lot. On Power's lot, number eleven, of the seventh range, the mineral has been mined, especially in a vein two and a half feet wide, increasing to three or four feet, in places, which is worked to a depth of twenty-five feet. The strike of this vein is almost east and west, with a dip to the north of < 80°. The coarse feldspathic gneiss adjoining the vein is full of bunches of apatite, with mica and pyroxene. Quartz occasionally occurs in amethystine crystals, but more often in bands of a flint-like variety, side by side with the apatite. One of these veins containing this variety, with much apatite, has a breadth of from three to four feet, and dips south-east < 45°. Several veins with an east and west strike, containing red and green apatite have been worked here. One was particularly well-defined, and measured twenty-six inches across. The corner of a ridge running north and south, on Power's lot, shews the contact of the gneiss with the crystalline limestone. The apatite is very abundant near this line of junction, and especially in the limestone.

McKinley's lot. McKinley's lot, number three in the eighth range of North Burgess, is on the shore of Otty Lake, and contains a vein of apatite from eight to nine feet wide, striking N.N.W. Upon this broad vein, consisting for the most part of apatite of the quality known as "firsts," though sometimes much intermixed with pink crystalline carbonate of lime, a shaft six feet square, and well timbered, has been put down under the direction of a Cornish miner, to a depth of forty feet, Not much water was met with. A second or smaller shaft, inclined, and on the foot-wall of the vein, was for the access of the miners. Levels had been driven to a distance of about 300 feet on either side, and a considerable amount of apatite raised. No work, however, was going on at the time of my visit.

South Burgess. On the second lot of the fourth range of South Burgess, on the south shore of Rideau Lake, apatite has been found, but there are no workings. On the first lot of the same range (Cantin's lot) apatite has been mined to some extent. It is tolerably pure, and is associated with large crystals of transparent carbonate of lime.

North Elmsley. In North Elmsley, on lot twenty-five of range eight, close to Mr. Power's house, occurs a great mass of crystalline carbonate of lime, full of cavities due to the solvent action of water, and sprinkled thickly with crystals of apatite of all sizes, often themselves cavernous and apparently water-worn. The strike of this mass, probably a vein, is N.E. and S.W. A considerable excavation has been made on this spot, and near here is the vein ten feet wide, mentioned by Dr. Hunt, in the Geology of Canada, page 761. From this pit some 100 tons of apatite were shipped. The strike of the vein, which has been traced across two lots, is N.E. and S.W. Near by occurs a vein of red apatite, which has been traced fifty feet W.N.W.

MICA.

The only deposit of mica recently worked in this region is that on the sixteenth lot of the ninth range of North Burgess, about nine miles from Perth. This lot is divided into two halves; that to the north belonging to John O'Neill, while the southern half is occupied by Mr. Bernard Quinn. North Burgess.

The mica on Quinn's land is not so plentiful as upon O'Neill's, but it is usually of better quality. The area upon which marketable mica has been found is comparatively small, being confined to the side of a hill. The whole of this area appears to consist of a granular pyroxenic rock, intersected by rudely defined confused veins or strings of mica, of various widths and without any tendency to parallelism. The largest crystals of mica are found where the mineral is less abundant in the rock; as where the mica forms a large portion of the whole mass, the crystallization appears to have been confused. A curious fact with regard to the distribution of the mica, pointed out by the manager, Mr. Baker, and observed by myself in several of the openings, is that wherever it has been found in large plates of marketable quality it is associated with veins of hematite from one to five inches in thickness, which is replaced by pyrites at a depth of about thirty or thirty-five feet.

A small shed stands on the summit of the hill from which the mineral is extracted, and contains tables and suitable knives for cutting the mica into the requisite sized plates. The mineral is roughly sorted at the quarry or mine, and all the plates worth cutting are sent up to the shed, where they are split by boys, with knives, to about one-eighth of an inch in thickness. Some of the largest crystals require to be hammered, so as to loosen their component plates sufficiently to allow of separation by means of the knife. The plates are then passed on to the cutters, which are knives working on the same principle as a tobacco-cutter, with strong blades about one foot in length. The shop is fitted for ten cutters, but six only were at work last year. Each plate is examined by the workman before cutting it, so that the best possible sizes may be obtained. The plates, after cutting, are again inspected by the foreman, assorted, weighed, packed in paper parcels, and labeled according to the size and quality. Among the causes which often render the crystals of mica inferior or unmarketable, are :—1st. Inferiority of color and consequent want of transparency; 2nd. Wrinkled or corrugated laminae; 3rd. Striation of the plates, often very evident; 4th. Cleavage joints;—the plates sometimes separate into strips as if cut with a sharp knife, and are consequently useless; 5th. The presence of imbedded minerals, such as quartz, apatite, pyroxene. Working of mica. Defects in mica.

The clippings, of which there have accumulated about seventy-five tons, may become valuable when smaller sizes are saleable. Ten per cent. of cut plates from the selected crystals is thought a very good yield; hence the evident economy of cutting at the mine, and thus reducing the expense of carriage. Under the old management, all the mica was transported nine miles, to Perth, for cutting and sorting; now the finished plates only are sent away from the mine.

REPORT

ON THE

COUNTRY NORTH OF LAKE SUPERIOR,

BETWEEN THE

NIPIGON AND MICHIPICOTEN RIVERS,

BY

MR. ROBERT BELL, C.E., F.G.S.,

ADDRESSED TO

A. R. C. SELWYN, Esq., F.G.S.,

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

MONTREAL, 22nd March, 1871.

SIR,—I have the honor to report that in compliance with your instructions, I organized a party, and proceeded in June last to Lake Superior, for the purpose of continuing the geological survey begun in that region in 1869; the results of which were given in my report dated May 31st, 1870, and published in the Reports of Progress for 1866–69, pages 313–364. The country examined extends about 170 miles in a straight line northward from the mouth of the Pic River, Lake Superior, and measures about 100 miles from east to west; embracing the tract between the meridian of Michipicoten and the height of land which separates the waters of Long Lake and the Albany River from those of Lake Nipigon.

Region explored

Acknowledgements.

As usual, when carrying on our operations in distant parts of the country, we were indebted to the officers of the Hudson Bay Company for much assistance, accommodation and information. Our thanks are especially due to Mr. S. Ironside, of Pic, and Mr. John Finlayson, of Long Lake House, for their kindness to a member of our party, during an illness of several weeks; and for keeping for us a regular register of the readings of the barometer and thermometer throughout the season, as well as for many other favors.

Having again been fortunate enough to secure the services of Mr. Peter McKellar, of Fort William, I was enabled to divide our party, and carry on two surveys at the same time. Mr. McKellar, assisted by Messrs. G. G. McKenzie and F. F. Kirkpatrick, made topographical and geological surveys of White River, which enters Lake Superior four miles south of the Pic, and of Na-ta-ma-sa-gami Lake, (about 18 miles long) at the head of the same river; of Black River, which enters the Pic near its mouth; and of Little Pic River and Whitefish Lake, besides numerous traverses by land. He also made a geological examination of the Slate Islands, which had never before been visited by an officer of the Geological Survey. The descriptions of the ground gone over by Mr. McKellar, which will be given in this report, are taken from that gentleman's plans and field-notes. In my own operations I was assisted by Messrs. W. W. Kirkpatrick and Alexander McKenzie. Careful surveys were made of the Great Pic River from Herrick's line to McKay's Lake; of the greater part of the same river from Lake Superior to that line; of McKay's Lake and the chain of lakes and streams leading from it across the height of land; and of the whole of Long Lake; as well as approximate surveys of the chain of lakes north-east of McKay's Lake (including part of Pow-gutch-a-wan Lake); the English River and and lakes upon its course for about 90 miles below Long Lake; besides numerous lakes and streams north-west of Long Lake House. These latter surveys were made by carefully observing the time required to traverse each distance in a canoe propelled at a known speed; and also, (in the case of rivers) by estimating the distance, in chains, from bend to bend; which I was enabled to do with considerable accuracy from long practice with the micrometer in river-work. The bearing of every line was taken by the compass. In the case of lakes, in addition to the above means, I sometimes made use of a rough kind of triangulation, by pacing base-lines along straight sections of the shores, and taking bearings from their extremities on various points visible from both. Explorations were also made into the country in various directions from the main lines of survey, and from the shore of Lake Superior; so that we are now in possession of a tolerably complete knowledge of the geographical and geological features of the whole of the area above indicated. In triangulating the larger sheets of water, such as Long Lake, base-lines were accurately measured, and the angles taken by the theodolite or by Troughton's repeating-circle, and in some cases with a good sextant. Rochon-micrometers and prismatic compasses were used in the surveys of rivers and small lakes. No marked local attraction, such as exists around Lake Nipigon, was observed in any part of the region examined. The true direction of our lines, and also the variation of the compass in different places, was ascertained by observations on the pole-star. The latitudes of numerous points were determined by both Mr. McKellar and myself from observations both of the sun and the pole-star; the artificial horizon having been used for this purpose in all

McKeller's labors.

Lakes & rivers surveyed.

Instruments & observations.

cases. The levels of lakes, heights of hills, falls, and rapids, and the rise and fall along rivers were ascertained by aneroid barometers, upwards of five hundred readings having been registered for this purpose. The readings of the barometer and thermometer (which were recorded for us twice a day, at 9 a.m. and 3 p.m., all summer, by the Hudson Bay Company's officers at Pic House on Lake Superior,) served for comparison with our observations in the interior. At the close of the season, copies of these readings were furnished to each of the surveyors who had been sent into the Lake Superior region by the Crown Lands Department of Ontario.

Barometer.

The depths of the lakes and rivers were taken in many places, and also the temperature of their waters. Notes were also kept in regard to the climate, soil and timber, the botany and zoology of the district, and particularly as to its physical characters, in reference to their bearing on the construction of the proposed Canadian Pacific Railway. From my knowledge of civil engineering, I was enabled to make many observations on this subject, which I believe will prove of value to the Government.

Maps.

In order to render the results of our surveys and geological investigations as clear and intelligible as possible, I have devoted a good deal of time to laying down the details upon maps, drawn mostly to a scale of forty chains to an inch.† Relying principally upon these as a record of the season's operations, it is only necessary, in the present report, to give a summary statement of the work performed, a general description of the character of the rocks, their geological structure, and the physical features of the region represented upon the maps; together with an account of the economic minerals, the surface-geology, soil, timber and climate.

Height of land

The height of land, which is considered as separating the Province of Ontario from the Hudson Bay Territory, runs in a very tortuous course through the region examined, and its position within these limits was pretty accurately defined.

Rocks met with.

The rocks which came under our observation belong to the Laurentian and Huronian series, except in the northern part, where they consist of unaltered Silurian strata. As might have been expected in so large an area occupied by these ancient crystalline series, we met with granitoid, syenitic, and schistose rocks in such variety as regards texture, color, hardness, and the relative proportions of their constituents, that detailed descriptions of them, taken from our notes, would not be possible within the limits of this report. I shall, therefore, merely allude to their general characters or their more notable peculiarities, and to the prevailing strike and dip over considerable breadths.

The following list shews the distances which were actually surveyed in the manner above described:—

† These maps are not published with the present Report.

Distances surveyed.

	Miles.
1. White River, from Lake Superior to the outlet of Na-ta-ma-sa-gami Lake, ...	43
2. Shores of Na ta-ma-sa-gami Lake (also called White Lake), exclusive of all islands, ...	67½
3. Black River, from its junction with the Bic to the head of the Fourth portage, ...	39
4. Pic River, from its intersection with Herrick's line upwards to the outlet of McKay's Lake. (The river passes in this distance through eight narrow lakes, including Waboosekon or Rabbit Lake,) ...	73½
5. Pic River from Lake Superior towards Herrick's line, ...	29
6. Shores of McKay's Lake, exclusive of all islands, ...	58
7. Shores of Granite, Mud and Hollow-rock Lakes (between McKay's Lake and Summit Portage) and streams connecting them, ...	25
8. Shores of Long Lake, exclusive of all islands, ...	192½
9. Making-ground River, from the intersection of Summit Portage to Long Lake, ...	11½
10. Little Pic River, from Lake Superior to a point above Herrick's line, ...	33½
	572½

The following are the total lengths of the portages which were either chained or measured by the micrometer, on the rivers actually surveyed :—

Portages measured.

	Miles.	Chains.
1. On White River, 18 portages ; total length, ...	3	43
2. On Black River, 4 portages ; total length, ...	1	38
3. On Pic River and the canoe-route thence to Long Lake House, 18 portages, (the last being that across the height of land) ; total length, ...	4	56
4. On Little Pic River, 5 portages ; total length, ...	0	38
	10	15

The following are the total lengths of the portages measured by pacing, on those river-routes and canoe-routes which were approximately surveyed :—

Portages measured.

	Miles.	Chains.
1. On English River, from Long Lake to Pembina Island, (below which there are said to be no more portages on this river, or on the Albany, all the way to the sea) 18 portages ; total length, ...	3	28
2. On the route followed by way of Manitounamaig and Ka-wa-kash-ka-ga-ma Rivers, 6 portages ; total length, ...	4	16
On the canoe-route between McKay's and Pow-gutch-a-wan Lakes, ...	4	40
	12	4

The distances in the following explorations by land, were, for the most part, ascertained by pacing :—

Traverses measured.

	Miles.
1. Two traverses between Black River and Na-ta-ma-sa-ga-mi Lake (14½ and 15½ miles), ...	30
2. Two traverses between Pic and Black Rivers, ...	7
3. Traverses from White River to Muskeg Lake, ...	5
4. Geological examinations made along Herrick's line from White and Black Rivers, ...	6
5. Several short traverses from either side of the last-mentioned rivers,	7½
6. Various traverses from Pic River and McKay's Lake, ...	16
7. Traverses in the region south of Long Lake, ...	14
8. Traverses east of the southern extremity of Long Lake, ...	6
9. Traverses west of the southern extremity of Long Lake, ...	7
10. Other explorations from the shores of Long Lake, ...	12
11. Two traverses between Little Pic River and Whitefish Lake, ...	15
12. Traverses westward from the mouth of Little Pic River, ...	2
13. Traverses in the neighbourhood of Mountain Lake and Steel River,	17¼
14. Traverses in the country between Peninsula Bay and Pic River, ...	21½
	169¼

The following distances were approximately surveyed in the manner already described :—

Distances surveyed.

	Miles.
1. English (or Kenogami) River from Long Lake downward to Pembina Island, including the distance between the inlet and outlet of Pine Lake, ...	90¾
2. Manitounamaig River, from the mouth to the lake of the same name, and between the other lakes upon its course, ...	15½
3. Ka-wa-kash-ka-ga-ma River, between the lakes, ...	19½
4. Shores of Pine Lake, on English River, ...	33
5. Shores of the part of Manitounamaig Lake examined. (The whole length of the shore is probably from 40 to 50 miles.)	20
6. Shores of Round Lake, on the Manitounamaig River, ...	6½
7. Shores of Muddy Lake, ...	8
8. Part of the shores of the Wa-wong Lake, on a tributary of the Ka-wa-kash-ka-ga-ma River, ...	17
9. Shores of Ka-wa-kash-ka-ga-ma Lake, on the river of the same name, ...	9
10. Shores of Fleming's Lake, on the last mentioned river, ...	28
11. Shores of Spring-water Lake, ...	13
12. Shores of Island-camp Lake, ...	9½
13. Shores of Egg Lake, ...	6
14. Shores of Mountain Lake, ...	13½
15. Shores of six smaller lakes, shewn on the plan of the country north-west of Long Lake House, ...	13
16. Shores of Whitefish Lake on the Little Fic River, ...	15
	316¾

Summary.

		Miles.	Chains.
1.	Distance actually surveyed on rivers and lakes, ...	572	50
2.	Portages chained or measured by the micrometer, ...	10	15
3.	Portages measured by pacing, ...	12	4
4.	Traverses by land, mostly paced, ...	169	20
6.	Approximate surveys on rivers and lakes, ...	376	60
		1,080	49

Summary of surveys.

Pic River.

The Indian name of this stream is Peek-ting or the Muddy River, so called from the large quantity of light-colored clay which it holds in suspension along its lower reaches on the melting of the snows, and after every shower of rain. It rises in McKay's Lake, near the height of land, and enters Lake Superior near its northwestern angle. From its mouth to the junction of the Black River, the breadth is about 700 feet, but above this point it contracts to between 200 and 300 feet, and becomes gradually narrower all the way to McKay's Lake, where it is less than 100 feet wide. The general upward course for the first twenty-one miles is almost due north. At the end of the second stretch, which is twelve miles long, bearing N. 30° E., we arrived at Herrick's line; thirty-two miles in a direct course from Lake Superior, or forty-five miles by the river. The third stretch lies between Herrick's and Beatty's lines, and is twenty-one and a-half miles long, bearing N. 15° E. The first three portages occur in this section. From the intersection of Beatty's line the upward course curves round till it has assumed a W.S.W. course. This fourth stretch, (seven and a-half miles between extreme points,) includes the fourth, fifth and sixth portages, and terminates in the southwest angle of Waboosekon or Rabbit Lake. This lake has the form of the letter L, each arm being two miles in length. The fifth section bears due north, with a length of twelve miles from angle of Waboosekon Lake; it includes portage seven to fifteen, and passes through five small lakes. From the upper extremity of the fifth section, the upward course curves to the left, till at the end of six and a-half miles, in a straight line, it has assumed a westerly diıection at the outlet of McKay's Lake. Half a mile below this lake there is a small rapid, which occasions the sixteenth portage.

Pic River.

The valley of the Pic will average about one mile in breadth. On either side, rounded hills of Huronian and Laurentian rocks are seen rising to heights varying from 100 to 400 feet, the more elevated being nearest Lake Superior. Below the third fall, (which is fifty-three and a-half miles in a straight line from Lake Superior), the valley is everywhere filled with clay and sand, arranged in terraces, the most marked of which are at ninety and 150 feet over the river; the latter being the average elevation of the highest banks. These

Valley of Pic.

Clay and sand.

deposits are very much cut up by deep ravines, giving the valley an extremely uneven bottom. Clay prevails in the lower part of the deposit, and fine sand towards the top. The clay occurs in thin layers (usually from half an inch to two inches in thickness, and averaging about one inch) of a bluish-drab color, interstratified with lighter beds of a fine sandy character; the whole having a conspicuously banded appearance. The bedding is usually horizontal, but occasionally it is tilted or contorted. Layers of cemented gravel were some times met with. The clay is highly calcareous. Dr. Hunt finds the various samples collected in different parts to contain, on average, upwards of thirty per cent. of carbonate of lime. The gravel and coarser sand consist, to a large extent, of the debris of limestone rocks, apparently derived from the calcareous strata north of the water-shed. These deposits appear to be of fresh-water origin.

Fresh-water shells.

On the east side of the river, at a point about nine miles below Herrick's line, in a bed of bluish-grey sand, underlaid by clay and overlaid by fine yellowish sand, (at a height of thirty feet above the river, and thirty feet below the top of the bank,) I found two species of the genus *Unio*, one of *Anodonta* and one of *Margaritana*; together with species of *Limnæa, Planorbis, Valvata,* and *Amnicola*; the whole being of a more southern type than the mollusca at present inhabiting the rivers and lakes of the neighborhood.

Land-slides.

All the way from the mouth to the first portage, a distance of forty-four miles in a straight line, or sixty-three following the stream, the river flows swiftly, with a smooth gliding current, which greatly impedes the upward progress of canoes, especially when the water is high. A few slight rapids, mostly over boulders, also occur, and, in going up, it is necessary to "track" loaded canoes past some of these with tow-lines. In this distance, steep banks of clay and sand rise, on alternate sides, to heights varying from thirty to 150 feet. Owing to the undermining action of the water, the banks in many places have given way, and precipitated great masses of the clay into the bed of the river, blocking up the stream and forcing it to excavate for itself new channels. These land-slides are occasionally upwards of an acre in extent. Below the first portage, the river averages about five feet in depth at low water, and from ten to fifteen when the water is high. The trees all along the banks are marked by the ice-shove, at a height of from twelve to fifteen feet above the summer level, and the river-silt is deposited on the bark and moss of their trunks, in places, as high as twenty-five feet over the same level. During low water, the banks are very steep and muddy, and thickly covered with brush, so that it is difficult to find good landing places for canoes.

Various rocks.

The rocks on the coast of Lake Superior, at the mouth of the Pic, consist of dark green trap and slate-conglomerate, on the east side, and fine-grained mica-schist, on the west side. On the east side, at the junction of Black River, a bare hill, consisting partly of grey and partly of red fine-grained granite, rises to a height of 200 or 300 feet from the edge of the water. From this point to a distance of about fourteen miles from Lake Superior, the

rocks in the hills, on either side, consist of a variety of dark grey hard siliceous and argillaceous slates, dark green massive and schistose diorites, crystalline reddish diorites, grey and greenish fine-grained quartzose mica-schists, and fine-grained hard grey imperfect gneisses, having a strongly marked regular banded appearance in weathered exposures. These rocks dip in various directions, but the general strike appears to be northeasterly. Huronian schists.

The exposures of Laurentian rocks seen along the river, (from their junction with those of the Huronian series, at the above distance, as far as the first portage), present nothing remarkable to note. They consist for the most part of the commonest varieties of grey and reddish gneiss. At the first portage the bedding is very distinctly marked by the interstratification of thin reddish and greyish quartzose and feldspathic bands with others of a black hornblendic and micaceous character; the dip being S. 20° E., at a high angle. The country was examined for a distance of about three miles on either side of the Sandy Hill Portage at the third or High Falls, and the surface found to be broken and hilly, consisting of bare reddish gneiss, running generally in a south-southwesterly course, with swampy patches interspersed. Bare rounded burnt hills rise to the height of from 100 to 200 feet, a short distance south of the river, between the High Falls and the fourth or Dying Portage. The highest of these we named Beatty's Mountain, from the fact that the line run by that gentleman crosses its summit near the intersection with the Pic River. It consists of common gneiss with granite veins, (some of which have a comb-like structure) and large patches of coarse red granite; one of the latter lying horizontally upon the vertical edges of the gneiss, which here strikes S. 80° E. From the Dying Portage to half a mile above the fifteenth portage, the gneiss is usually of a thin-bedded micaceous character, and bands of considerable thickness consist of mica-schist. Crystals and lumps of garnet are abundant; in the neighborhood of the eleventh portage some of the latter measure nearly a foot in their greatest diameter. Around Jackfish Pond, (between the fourth and fifth portages,) we observed in these rocks a few irregular veins of light-colored granite, containing large scales of black mica; and in the same locality, some small patches of black iron ore. A large exposure of massive light grey gneiss or granite, consisting principally of white quartz and feldspar, and weathering white, occurs in form of the number of low bare ridges, which we called the White Granite Hills, on the west side of the river, about three miles, in a straight line below McKay's Lake. Another marked change in the character of the rocks is met with at the sixteenth portage, half a mile below the outlet of this lake. Here, and almost everywhere on the shores of McKay's Lake, they consist of tender grey mica-schist, usually with rusty surfaces, and thickly studded with small garnets. In weathered cliffs the rock has often the appearance of sandstone. Westward, the same strata re-appear in their strike, with a breadth of about two miles on the shores of Long Lake. In some places

Laurentian gneiss.

Beatty's Mountain.

Gneiss and mica-schist.

Tender mica schists.

on McKay's Lake, at the sixteenth portage, and on Long Lake, they are cut in various directions by regular and irregular veins of coarse light-colored granite, composed of white and yellowish-white feldspar, translucent quartz, usually lilac and rose colored, with black and silvery mica. No other minerals were found in any of the veins which we examined. It will be observed by the following list, giving the run of the rocks at intervals all along the Pic River and around McKay's Lake, that both the micaceous and massive gneisses, and the mica-schists above described, have the same general strike; ranging from about S. 70° W. to S. 80° W. The average direction of the strike of the gneiss is the same over a large section of country northwest of Long Lake House. This bearing also corresponds with the general run of the gneiss between Thunder Bay and Dog Lake, as given in my report of last year. Dr. Bigsby says (Geol. Journal, VIII, 402) that all around Rainy Lake and the Lake of the Woods, and for a long distance southward into the United States, the average run of the gneissoid rocks is the same, being W. S. W. This also corresponds with the general course of the ice-grooves, and with one of the sets of the mineral veins and of the trap dykes of the region.

Granite veins.

Dip and Strike of Rocks on Pic River.

		Mag. bearing.
1.	Average strike of gneiss between the junction of Huronian rocks and Herrick's line, ...	S. 75° W.
2.	Strike of gneiss at a point 3¼ miles in a straight course above Herrick's line, (exceptional). Dip E. < 65°	N.
3.	Do. one mile S. W. of the mouth of Jackfish River, ...	S. 75° W.
4.	„ at the 1st portage. Dip southward at a high angle, ...	S. 70° W.
5.	„ 2¾ miles above the 1st portage, ...	W.
6.	„ at Beatty's Mountain, ...	S. 100° W.
7.	Average strike for 3 miles on either side of 3rd or Sandy Hill Portage	S. 70° W.
8.	Do. on Dying Portage and around Jackfish Pond	W.
9.	„ around Waboosekon Lake. Dip southward at a high angle	S. 70° W.
10.	Strike at 7th portage, ...	S. 70° W.
11.	„ 9th portage, ...	S. 65° W.
12.	„ on Zhush-quai-be-ga Lake, between the 9th and 10th portages, ...	S. 70° W.
13.	„ „ „ „ „	W.
14.	Do. ¾ of a mile below 12th portage. Dip northward, ...	S. 80° W.
15.	„ at the 12th portage. Dip southward, ...	S. 45° W.
16.	„ around Sagi-wa-tan Lake, above the last, ...	S. 72° W.
17.	„ at the 13th portage, ...	W.
18.	„ half a mile above the 15th portage. Here the massive gneiss takes the place of the micaceous gneiss, which has prevailed from the 4th portage, ...	W.
19.	„ 1 mile above the 15th portage, ...	S. 80° W.
20.	„ 2 and 2½ miles above the 15th portage, ...	W.
21.	„ 3½ and 3¾ miles in a straight line below McKay's Lake, ...	W.

		Mag. bearing.
22.	Strike on south side of the White Granite Hills; 3 miles in a straight line below McKay's Lake, ...	S. 95° W.
23.	,, on north side of do.	S. 70° W.
24.	,, at 16th portage, half a mile below the outlet of McKay's Lake. Here the tender grey mica-schists begin. Dip northward < 70°	S. 70° W.
25.	,, between the 16th portage and McKay's Lake, ...	S. 72° W.

Dip and Strike of Rocks on McKay's Lake.

26.	Strike on south side of lake, one mile S. W. of Camping Point on the opposite side. Dip southeastward < 50°...	S. 55° W.
27.	,, on north side, half a mile west of Camping Point. Vertical	S. 60° W.
28.	,, on north side, 1½ mile W. of same point. Dip north or vertical	W.
29.	,, on south side, opposite the extremity of Long Point. Dip S. 45° to horizontal, ...	W.
30.	,, on south side, 1½ mile W. of last. Dip southward, < 70°	S. 73° W.
31.	,, on south side 1½ mile W. of last (opposite western extremity of Big Island). Vertical	S. 70° to 84° W.
32.	,, on Burnt Hill Point, near west end of lake. Dip southeastward < 65°	S. 68° W.
33.	,, along north side of Big Island. Dip southward < 70°	W.
34.	,, near northeast extremity of Big Island. Dip south-eastward < 60°	S. 65° W.
35.	,, on islet on east side of Big Island. Dip south-eastward < 80°	S. 73° W.
36.	,, along straight shore on north side of Long Point, between Morrin's Channel and Reedy Bay. Dip northeastward < 80°	S. 70° W.

Near the outlet of McKay's Lake there is a small islet of coarse reddish-grey granite; but this is the only locality where this rock was noticed around the lake, except in the veins already mentioned, and indeed this may belong to a vein of unusually large size. A trap dyke, seventy feet wide, running S. 21° W., cuts the northeast extremity of Big Island. In the centre it is crystalline and grey; at the sides, fine-grained, hard, and bluish-black, and holds small translucent crystals of white feldspar. Its direction corresponds with that of Morrin's Channel and the bays to the north and south, in the same line; and it appears as if its existence has had something to do with the denudation which has taken place along the eastern side of its course, producing the depression now occupied by the water. This is about the direction of most of the trap dykes which we met with in this region; and it would not be surprising if the above supposition should also account for the formation of the valley of Long Lake, which is cut in a singularly straight course across the strata; its uniformity being unaffected in passing from one kind of rock to another. Trap dykes were found in several places, parallel to the shores of

Large trap dyke.

this lake, and to the cliffs on either side, and directly opposite the southern extremity an enormous dyke cuts the strata in a course bearing N.N.E. and S. S. W., which coincides with that of the lake.

McKay's lake. McKay's Lake is twelve miles long by two and a-half in width. Its general course is N. 60° E. and S. 60° W. Long Point, running in from the northeastern end, divides it into two channels, for about half its length. This tongue of land is separated by Morrin's Channel from Big Island, which has a length, in the same direction, of four and a-half, by a breadth of two miles; thus filling up a great part of the main body of the lake. The country immediately around McKay's Lake, especially on the north side, is hilly and rather barren; but none of the elevations appeared to exceed one or two hundred feet above the water. Three brooks enter the western end of the lake, which is divided into several bays. The canoe-route leading southwestward, through Eagle-Rock Lake, on Beatty's line, begins in the most southern of these. The outlet of the lake is at the eastern extremity of the southern channel. A brook from the eastward enters the head of the northern channel, and in this the canoe-route leading northeastward to Pow-gutch-a-wan Lake begins. This lake, which is said to be of about the same size as McKay's Lake, lies at the distance of about eight miles from the northeastern extremity of the latter, and was only partly explored. In taking canoes from one to the other, a chain of seven small lakes, and six brooks, is followed; and five portages are made, having a total length of four and a-half miles, as determined by pacing. The height of land between the waters of the Pic and those of Pow-gutch-a-wan River, (a branch of the Albany) crosses this route on the fourth portage, and at a distance of about four and a-half miles, in a straight line, from McKay's Lake.

Powgutcha-wan lake.

Height of land.

Route to Long Lake. In going from McKay's to Long Lake, we entered a narrow arm, a mile deep, called Yankee Bay, on the north shore of the former, about two and a-half miles from its northeastern extremity. From the head of this bay, we followed a marshy brook, fifty-five chains to Granite Lake; which is about one and three-quarter miles long, in a northerly direction. About the middle of the western side of this lake, we turned west into the upward continuation of the brook, (which again flows through marshy ground,) and, at the end of a mile and a quarter, entered Mud Lake. At the extremity of Mud Lake, which is three and a quarter miles long, bearing W. S. W., we arrived at the Summit Portage. At the lower end of this lake, a bay a mile and a quarter long, stretches to the south; and from the opposite side, (and connecting with Mud Lake by a short narrow channel,) Hollow-rock Lake stretches north, about two and a-half miles. The only interruption to canoe-navigation between McKay's Lake and Summit Portage, is a carrying-place, one chain in length, along a slight rapid, with shallow water; which occurs on the brook between Granite and Mud Lakes. This is the seventeenth portage. Summit Portage, the eighteenth and last, on the route from Lake Superior to Long Lake,

Summit Portage.

measures 132 chains in a straight line, bearing S. 83° W., between its extremities, or 139 chains, following the trail. It leads over dry and tolerably level ground from Mud Lake to the Making-ground River. Mud Lake, according to our barometrical observations, is fifteen feet above this stream, at the western terminus of the portage; and the highest point on the trail is fifty-seven chains from the lake, and fifty feet above its level.

The Hudson Bay Company's boat roll-way, parallel to the trail, and a short distance to the north of it, passes over level swampy ground. From the Summit Portage, we followed the Making-ground River, flowing northeasterly, down to Kenogami or Long Lake, which we reached at the end of eleven and a-half miles, by the stream. Long Lake House—a Hudson Bay Company's trading post—stands on the northwest side of the lake, opposite the mouth of the above river, and about a mile and a-half from the outlet. Long Lake house.

Massive red granite is largely exposed on the east side of Mud Lake and around the south end of Granite Lake, and it is again met with towards the mouth of the Making-ground River; while greyish syenite is found at the head of Yankee Bay, and towards the northern parts of Granite and Hollow-rock Lakes. A hard dark fine-grained silicious and micaceous schistose rock, holding minute garnets, occurs at Shanty Point, a short distance east of Yankee Bay. The Summit Portage runs upon the vertical edges of a fine-grained dark green mica-schist, holding thin lenticular veins of white quartz, parallel to the cleavage or bedding, which strikes S. 80° W. The same rock continues down the Making-ground River to within about two miles, in a straight line, of its mouth. This point is in the strike of the same rock where it first makes its appearance on the east shore of Long Lake, five and a-half miles from the outlet. At the Upper Little Rapid, it dips northward at an angle of 60°, and a little lower down, at an angle of 70°. At the second or Lower Little Rapid on this river, on the east side of Hollow-rock Lake, and towards the west end of Mud Lake, thin-bedded imperfect grey gneiss is met with, apparently occupying a position between the granites and the fine-grained green mica-schists. On some of the islands in Mud Lake, a very dark greyish-green diorite, rendered porphyritic by the presence of crystals of hornblende, is found, apparently associated with the imperfect gneisses. The fine-grained green mica-schists, and the imperfect gneisses are supposed to be of Huronian age. Granite. Mica-schist. Greenish schists. Thin-bedded gneisses. Diorites.

Portages on Pic River Route from Lake Superior to Long Lake.

Portages.

Number of Portage counting from Lake Superior.	Distance from Pic Post, in a straight line, to foot of Portage.	Side of River.	Length in Chains.	Rise in feet.	Remarks.
I.	44	E.	7	44	Fall in two leaps; part of trail steep; carry canoes.
II.	51½	W.	5	27	Fall of about 20 feet at bottom; very steep sand-bank at lower extremity of trail, 66 feet high; ditto at 38 feet.
III.	53½	W.	23	90	Called the High Falls; nearly perpendicular, over gneiss; the present trail leads up the face of a sand-covered terrace, the crest of which is about 140 feet above the river below; it is known as the Sandy Hill Portage.
IV.	55	W.	87	68	Called also the Dying Portage. Whole ascent in the rapids from the foot of this portage to Ka-we-pe-te-que-wa Lake, at the head of the portage, about 95 feet.
V.	56	W.	23	27	From northern extremity of Jack-fish Pond to Ka-we-pe-te-que-wa Lake.
VI.	56¾	E.	10	18	Strong rapid; carry canoes over lower half; pole up the upper half.
VII.	59	E.	3	7	Rapid; tow or pole canoes up; run canoes down.
VIII.	59¼	E.	7	10	do do do
IX.	59½	E.	13	16	do do do
X.	60	W.	7	15	do do do
XI.	61	E.	16	17	do do do
XII.	63	W.	8	4	do do do
XIII.	66½	W.	12	10	do do do
XIV.	67¼	W.	5	6	do do do
XV.	67½	E.	8	12	do do do
XVI.	74½	E.	2	3	Rapid; tow or pole canoes up; run them down. Half a mile below outlet of McKay's Lake.
XVII.	78½	S.	1	2	Carry canoes, owing to want of sufficient water in the small rapid.
XVIII.	79¾	....	139	15 fall.	Summit Portage 3¾ miles west of last.
Total length of portages			4 m. 56 c.		

The following list shews some of the levels along the above route, as accurately as our opportunities allowed us to determine them by the aneroid barometer, counting from the surface of Lake Superior which is 600 feet above the sea:—

Levels on the Pic River Route.

Levels over Lake Superior.

Intersection of Herrick's line with Pic River, ...	60
Bottom of First Portage, ...	82
Top of same, ...	126
Bottom of Second Portage, ...	140
Top of same, ...	167
Bottom of Third Portage, ...	171
Top of same, ...	261
Bottom of Fourth or Dying Portage, ...	266
Jackfish Pond between Fourth and Fifth Portages, ...	334
Ka-we-pe-te-que-wa Lake at head of Fifth Portage,... ...	361
Rabbit or Waboosekon Lake, ...	385
McKay's Lake, ...	500
Mud Lake, ...	504
Intersection of Summit Portage and Making-ground River,	489
Long Lake (mean calculated from over 60 barometric readings,	466

Various other Levels.

Other levels, over Lake Superior.

Pine Lake on English or Kenogami River	344
Long Island on English River (same level as Lake Superior)	
Pembina Island, *below* the level of Lake Superior, 120 feet.	
Manitounamaig Lake, N. W. of Long Lake House	486
Round Lake, half a mile from the last (same level) ...	486
Muddy Lake, N. W. of Long Lake House	498
Fleming's Lake, ,, ,, ,, ...	541
Ka-wa-kash-ka-ga-ma Lake, ,, ...	522
Egg Lake ,, ,, ,, ...	546.
Mountain Lake ,, ,, ,, ...	553

The following are the principal tributaries of the Pic:—

Tributaries Pic River.

1. Wa-ba-keek, or White Otter River, on the east side, one mile in a straight course, below Herrick's line.
2. Jackfish Brook, on the east side, nine and a-half miles above the same line.
3. Ka-gee-noo-ga-ma (also called Sturgeon) River, on the west side, ten miles above the same line.
4. Second Portage Brook, on the east side, at the foot of second portage.
5. Ka-ga-ge-wabic River on north side, one mile in a straight line above Beatty's line, or one mile below Dying Portage.
6. Waboosekon Brook, on the south side, at the south-west angle of the lake of the same name. A canoe-route leads southward by this brook to Ka-gee-noo-ga-ma River.
7. The five brooks flowing into McKay's Lake, as already described.

Kenogami or Long Lake.

Kenogami or Long Lake.

The southern extremity of Kenogami or Long Lake is about twenty-two miles due north of Jackfish Bay, opposite the Slate Islands. The height of land between the waters of Lake Superior and those flowing into Hudson's Bay, passes about one mile south of this point, or twenty-one miles north of

Height of land.

Lake Superior. Long Lake, for the first eight and a half miles, runs nearly due north. The breadth in this part varies from two to forty chains, and averages about twenty. From this point to the outlet, its course is nearly straight, bearing N. 30° E. (ast.); so that its general bearing, from one extremity to the other, is about N.N.E. The average breadth of the main section, forty-six miles in length, found by taking the mean of fifteen measurements, at equal distances, is 104 chains, or a little over a mile and a quarter. Following the axis of the lake, the whole length will therefore be fifty-four and a half miles, while in a straight line between extreme points it is fifty-two miles. As already stated, the shore-line measures 192 miles, exclusive of islands.

The following are the principal streams which enter Long Lake:

Tributaries of Long Lake.

1. Hane's River, on the west side, at eight and a quarter miles from the southern extremity.
2. Ka-we-sa-qua-ga-ma, or Paint River, which enters the same side, from the south-westward, at two miles north of Beatty's line.
3. Ka-muck-a-ti-wa-ga, or Black-water River, which enters the same side from the north-westward, three miles north of Beatty's Mine.
4. Kin-ongé, or Pike River, also on the west side, eight miles from the outlet.
5. Making-ground River, on the east side, one and a quarter miles from the outlet.

Black River.

The valley of Black River, and the southern part of that of Long Lake, form one continuous depression, running due north and south. Its sides are lined with long moraines, composed of well-rounded boulders. Numerous ponds lie amongst these, in the lower levels. Black River takes its rise in a chain of these ponds, connected together by short links of sluggish water; the northernmost pond being only a little over a mile south of Long Lake. This route can be followed in small light canoes to Lake Superior; but is never attempted by larger ones, on account of difficulties in the navigation of Black River.

Shores of Long Lake.

The country around the southern part of Long Lake is rugged and mountainous, with very little covering of any kind upon the hard gneiss rocks. What appeared to be the highest of these hills, lies at a distance of two and a half miles west of the extremity of the lake, and is, by barometrical measurement, 540 feet over its level. Going northward, the hills become gradually lower, until about half way down the lake, (or at thirty miles on the west side, and twenty-four on the east, from the outlet,) the country has assumed a comparatively level aspect; with an occasional hill from fifty to one hundred feet high.

Bridging Long Lake.

In reference to the route of the proposed Canadian Pacific Railway, I may mention that Long Lake might be bridged at various points between its southern extremity, and Ka-wa-ba-tong-wa or The White Sand-banks, eleven miles north of it. At this place, a low island is separated from

the eastern shore by a shallow creek, and from the western shore by a channel about fifteen chains in breadth; which I found to measure fifty-six, sixty-two, fifty-five and thirty-six feet in depth, at equal distances from its eastern edge, as represented upon the plan. A brook enters the lake from either side, near this point, and the valleys of these brooks may be found to afford good approaches. The lake might also be bridged at the Northern Narrows, which begin at seven, and extend to ten and a half miles from the outlet. In this interval, the shores are only thirty chains apart, at several points; and at the latter distance, an island in the middle reduces the breadth to fifteen chains on either side of it.

The line run last summer by Mr. Walter Beatty, P.L.S., south-easterly from Lake Nipigon, intersects the west shore of Long Lake at fifteen and a half miles from its southern extremity, or twenty miles north of Herrick's line. The latitude of this point, from the mean of several observations both of the sun and pole-star, I found to be 49° 22′ 30″. Beatty's line.

Around the southern part of Long Lake, and as far north as Beatty's line, the prevailing rock consists of the common variety of gneiss, with the usual W.S.W. strike. But from this point to within eighteen miles of the outlet, a very coarse light reddish-grey granite prevails. It is composed of whitish quartz and very large crystals of light colored feldspar, with occasional flakes of mica. At the above distance, the tender grey mica-schists, similar to those of McKay's Lake, (and also cut by the same kind of granite veins,) begin, and continue for about two miles down the shore. Near the termination of the two miles referred to, finely grained, highly fissile mica-schists make their appearance; and are almost continuously exposed for about eleven miles along the east side, and for about the same distance (or to the Kin-ongé River) on the west side. They stand nearly on edge, all along, the strike gradually changing from about N.W. on the southern, to S.W. on the northern side of the above breadth. The prevailing color is dark greyish-green, but some considerable bands are yellowish-grey and olive colored, with a talcoid aspect. The northeastern strike of the northern limit of this mica-schist formation continues to the Making-ground River; which it intersects at about two miles, in a straight line, from its mouth. In one place on the east side of this narrow part of the lake, ordinary gneiss, running S. 70° W., and dipping northward at an angle of 45°, is seen below the fine green mica-schist. A small island in the same neighborhood is composed of a rock resembling the imperfect grey gneiss of Hollow-rock Lake and other localities already mentioned. It runs S. 70° W., is hard, fine-grained, grey, silicious, and somewhat micaceous, and contains numerous small patches and short cross veins of white quartz.

Rocks on Long Lake.

Granite.

Gray mica-schists with granite veins.

Greenish talcoid mica-schists.

Underlying gneiss.

Northward from the limit of the greenish mica-schists just described, the shores and islands of Long Lake are occupied by a massive, reddish-grey, rather coarse-grained syenite, composed of translucent quartz, white and red Syenite.

feldspar, and dark green hornblende, with a little black mica. The same rock continues to be exposed in the hills on either side of the English River, as far down as the first portage.

THE KENOGAMI OR ENGLISH RIVER.

Kenogami River.

The Indians call this stream, which discharges Long Lake into the Albany, Kenogami-sibi, or Long-Lake River. This name would be preferable to the one hitherto used on sketch-maps, as there are several other English Rivers in the Hudson Bay Territory.

Leaving Long Lake, the Kenogami River winds for two miles among open marshes, on which the Hudson Bay Company's men cut hay for the use of the cattle at Long-Lake House. The general course of the river, for the first nine miles, is N. 10° E. In this section, the first portage occurs at three, and the second at seven and a half miles down; and between them, on the west side, Kenogami-shish, or Little Long-Lake River, enters at five, and Manitounamaig, or Devil-fish River, at six miles from Long Lake. From the outlet to the first of these tributaries, the river is only from a chain and a half to two chains wide; but below them it expands to four chains. Further down, it continues to increase in width, till, at the end of ninety miles (following the stream) from Long Lake, it averages ten or twelve chains. At the end of nine miles from Long Lake, the river bends round, running N. 86° E. in a straight line, for eight miles; when it enters the west side of Mani-gwa-ga-mi, or Pine Lake, at right angles, about two miles from its southern extremity. Portages III to VII occur in this second stretch, and a river enters from the north. The main body of Pine Lake, which runs N. 12° E., is about seven and a half miles long, and one and a half wide. At a mile and a half from its northern extremity, a channel ten chains wide leads into the lower division of the lake. This runs N. 25° E., and is three and a quarter miles long and one mile wide. About one and a half miles from Pine Lake, we reach the eighth portage, and immediately below it Arm Lake; which is about three miles long, and lies at right angles to the general course of the river. The ninth portage is passed at two miles below Arm Lake, and half a mile further on, the river enters Ka-pees-a-watan Lake, two miles long, in which there are several low islands. Mani-gwa-ga-mi-shish, or Little Pine River, flowing from a lake of the same name, enters the south side of this lake; and the Wa-big-a-no, or Mouse River, comes in from the same side, about two miles, in a straight line, below the lake. A smaller river, also from the south, enters at one mile below the last. This third stretch of the river, which has a nearly east course below Pine Lake, terminates with a rapid a mile and a half long. This is avoided by the eleventh portage, the tenth being one mile higher up.

Pine Lake.

The fourth reach of the Kenogami river bears N. 45° E., and is thirteen and a half miles long, in a direct line. It embraces portages XII to XVII, and terminates at the eighteenth; which is the last to the junction of the river with the Albany; on which canoe-navigation is uninterrupted to the sea. The Atick, or Deer River, enters from the north, between the sixteenth and seventeenth portages. **Kenogami River.**

The fifth reach bears N. 30° E., and was followed for twenty-one miles, when we reached Pembina Island; which, although not large, is easily recognised by a conspicuous, light-colored bank, about thirty-five feet high, running for about a mile along the north side of the river, immediately above it. Throughout this last stretch the river is shallow, swift, and sometimes rapid. In the last twelve miles explored, it spreads in several places among low islands, and flat-lying limestone is exposed in the bed of the river. In the same interval, it receives the Mun-did-i-no and Wa-tis-ti-qum Rivers from the north, and the Pe-wo-na or Flint River from the south. **Pembina Island.**

The last exposure of gneiss is seen about three-quarters of a mile below the lowest portage, or nearly seventy miles from Long Lake, following the river, and the first exposure belonging to the great continuous area of unaltered flat-lying strata; is about one and three-quarter miles further down. This consists of a thinly-bedded, greenish-drab, soft, fine-grained, calcareo-argillaceous sandstone, without observed fossils. Between this point and Pembina Island, the strata exposed in the bed of the river consist of thinly-bedded, yellowish and drab-colored argillaceous limestones and shales. In the bank just above Pembina Island, a section of about twenty feet consists of soft-greenish-drab earthy and porous argillaceous beds, from six to eight inches thick; underlaid by a few feet of yellowish-drab and bright brownish-yellow calcareous beds, having a conchoidal fracture, and measuring from two to five inches in thickness, These strata are as nearly as possible horizontal. They appear to hold no fossils; but in the gravel and shingle, which contains much flint all along the last stretch of the river explored, numerous fossils, mostly silicified, occur. Amongst these, Mr. Billings has recognised four corals, namely, *Favosites Gothlandica*, *Halysites catenulatus*, a *Syringopora*, and a *Zaphrentis*; two brachiopods, namely, a small *Strophomena*, and a *Rhynchonella*; together with a trilobite belonging to the genus *Encrinurus*. He says, "I consider these fossils to be Upper Silurian, about the age of the Niagara formation." At about half a mile below the Atick or Deer River, and two and three-quarter miles above the eighteenth portage, flat-lying, fossiliferous sandstone is exposed in a cliff about fifteen feet high, on the north side of the river. The rock, which is calcareous, and of a dark greenish-grey color, is composed of coarse rounded quartz grains, in a matrix of finer particles. It soon crumbles into sand on exposure to the weather. The thickest bed measures beween two and three feet. The thinner layers are more darkly colored than the others, and somewhat bituminous. One of the **Gneiss.** **Sandstone.** **Limestone and shales.** **Horizontal strata.** **Silurian fossils.**

ossils. lowest beds is full of finely disseminated iron pyrites. The commonest fossils in these beds consist of very small orthoceratites, which are closely crowded together on the surfaces of some of the beds. There is also a large-chambered shell, like a *Nautilus*, and what appears to be a small *Holopea;* but Mr. Billings does not think these fossils are sufficient to determine the age of this deposit, even approximately. Laurentian gneiss is exposed in several places on the river, between this sandstone and the commencement of the main body of the palæozoic rocks, below the eighteenth portage.

Gneiss and syenite. It has been already mentioned that the syenite of Long Lake extends down the river as far as the first portage. Several kinds of gneiss prevail all the way from this point to the commencement of the palæozoic rocks, with the exception of about four miles, (from a point above the twelfth to the sixteenth portage,) which are occupied by reddish and bright grey syenite,—and a patch of close-grained, greyish-green trap at the head of the twelfth portage. Leaving the first portage, the general strike is south-westerly; further on, it becomes more nearly east and west; and, finally, towards the eighteenth portage, about north-west and south-east. The most remarkable variety of gneiss observed occurs at the ninth and tenth portages. It is very evenly bedded, grey and micaceous, and contains large crystals of feldspar, which give the rock the appearance of a conglomerate. At the ninth portage, where the dip is N. 10° E. < 35°, these crystals are milk-white; and at the tenth, where the dip is N. 10° E. < 45°, they are of a reddish color.

Banks of Kenogami River. The English or Kenogami River flows through a level country all the way from Long Lake to the Albany. Some ridges and knolls of syenite and gneiss occur at intervals, in the upper part of its course; but even these disappear below Pine Lake, and the whole surface becomes uniformly level. Banks or terraces of brown loam and gravelly earth, varying from ten to about forty feet, but averaging about twenty in height, occur nearly all along the sides of the river, as far as we explored it, and also around Pine Lake. Terraces. In rapid parts, these terraces approach close to the water's edge; but at other places they generally recede, on one side to at least, a short distance from the river. The soil on the top of the banks, and to some distance from the river, appeared very good in most of the localities examined. The timber consists mostly of spruce, balsam-fir, white-cedar, tamarack, white birch, and aspen. Forest trees. Some of the larger spruces and tamaracks measured between five and six feet in girth, at five feet from the ground; but the average diameter of the larger trees would be about eighteen inches. In the last twenty or thirty miles explored, the ground became swampy on going back to a short distance from the river, on either side; the timber consisting of small spruces, cedars, and tamaracks. The Indians report the same conditions to prevail over a very large area in this section; while nearer James's Bay, the ground is still lower and more swampy, and is interspersed with large

and very shallow lakes, and with bogs and marshes, in which great numbers of water-fowl breed in security, their haunts being inaccessible, either on foot or by canoe. Some of the bogs are said to be so wide that one cannot see across them, and the only objects that break the outline of the horizon are a few stunted black spruces, standing far apart.

Portages on English River, counting from Long Lake downward: Portages.

No. of Portage.	Side of River in feet.	Approximate length in chains.	Fall in River in feet.	Remarks.
I.	Left.....	14	20	Trail level and dry. Carry canoes.
II.	Left.....	5	7	do do Wade light canoes.
III.	Left.....	12	22	Banks of gravelly earth. Carry canoes.
IV.	Right . .	9	25	Burnt land. Sandy trail. Wade light canoes.
V.	Left.....	6	12	Run light canoes.
VI.	Left.....	3	4	do.
VII.	Right ...	34	24	Steep bank at lower end. Carry canoes.
VIII.	Right ...	4	3	Run light canoes.
IX.	Right ...	2	10	Over rocks. Carry canoes.
X.	Left.....	6	12	Lower end steep and rocky. Carry canoes.
XI.	Right ...	120	75	Trail level, but intersected by a few small ravines. Steep bank near lower end. Soil yellow clay, overlaid by gravelly loam. Carry canoes.
XII.	Left.....	1	7	Over rock. Carry canoes.
XIII.	Right ...	5	10	do. do.
XIV.	Right ...	12	15	Level trail. Run light canoes.
XV.	Left.....	5	6	do. Carry canoes.
XVI.	Right ...	25	20	do. Wade full canoes.
XVII.	Left.....	4	6	do. Wade light canoes.
XVIII.	Right ..	1	4	Numerous small islands of gneiss in river. Run full canoes down; wade up.

THE COUNTRY NORTHWEST OF LONG LAKE HOUSE.

The Manitou-namaig River enters the Kenogami River at six miles, in a straight line, from the outlet of Long Lake. Canoe-navigation is interrupted by a rapid close to the mouth, around which there is a portage, on the north side, of twenty-six chains. The upward course of the river is N. 57° W. (mag.), four miles to the lake of the same name; the river in this distance being broken by a few rapids, with boulders, which however do not necessitate portages. This lake has the form of the letter L reversed. The lower portion, which is about six miles in length, with a breadth varying from three to about 110 chains, runs N. W.; while the upper portion, which is said to be over twelve mile long, runs S. W., and varies from twenty to about 100 chains in width. The upward continuation of the river leaves the northern extremity of the lake at the angle formed by the two stretches described. Following this, through a sluggish stream, at the end of half a mile we come to Round Lake, about two miles long. The course of the river above Round Lake is about west, for five and a-half miles; entering Arm Lake, one mile in Manitou-namaig River.

diameter, at the distance of about a mile from Round Lake, and terminating in a shallow lagoon, half a mile wide; above which the main river turns southwestward, and was not explored any further. The above stretch consists of dead water, with the exception of a slight *chute* a short distance above Arm Lake, but this is passed without portaging. A very crooked stream, called Mink Brook, enters the river half a mile below the lagoon. Following up this, at about two and quarter miles in a straight line, we came to Muddy Lake; which is two and a-half miles long and one mile wide. Only one slight *chute* occurs in the course of Mink Brook, and even here, a portage is unnecessary. At a bay on the west side of Muddy Lake, a portage three-quarters of a mile long, runs southwestward to Spring-Water Lake. From the northern extremity of Muddy Lake, a stil-water brook, half a mile long, led us to a pond called Head Lake.

Kawakashka-gama River. From Head Lake a portage-trail runs northwestward a mile and a quarter, mostly over swampy ground, to the lower part of Fleming's Lake, on the Ka-wa-kash-ka-ga-ma River, another branch of the Albany. Fleming's Lake (so named after the chief engineer of the Intercolonial Railway) runs N. E. and S. W. and is five and a-half miles long by one mile and a-half wide, with the exception of a narrow part in the middle. The outlet at the northeast extremity, breaks through a ridge of boulders, producing a rapid; but below this the river is smooth to Ka wa-kash-ka-ga-ma Lake, which lies about a mile and a half to the north, and is three miles long by two wide. The river discharges from the northwest angle of this lake, and flows smoothly, in a westward course for a considerable distance. At two miles below the lake, a portage-trail, three-quarters of a mile long, runs from the river northward to a beautiful sheet of water called Wa-wong Lake; which discharges into it by a small brook, in the same neighborhood. Wa-wong Lake is of a very irregular form, but its general outline will probably measure six miles from east to west by three

Various lakes. from north to south. According to the sketch-maps and descriptions which we received from the Indians, the Ka-wa-kash-ka-ga-ma River, after flowing a considerable distance westward, turns northward, passing through two lakes, and finally runs eastward to the Kenogami. This great bend in the river sweeps round Os-kan-a-ga or Bare-Bones Lake, which is said to be one day's journey by canoe (or about twenty-five miles) in length. Below the lakes just mentioned, the river is called Pe-gun-a-kai-gun, after the lowermost of the two lakes. This route is sometimes used by the Indians in coming from the Albany to Long Lake House, the amount of portaging being less than in following the Kenogami River the whole distance. A few miles below the trail to Wa-wong Lake, a branch, which the Indians follow in going to Lake Nipigon, is said to enter the Ka-wa-kash-ka-ga-ma River from the southward.

The upward continuation of the river is found at the southwestern extremity of Fleming's Lake. Spring-water Lake lies about a mile and a-half south of this part of the river, into which it discharges by a small stream, and

measures three and a-half miles in length, in a northeasterly direction. Six other lakes, connected with the same water, are found at short distances southwest of Fleming's Lake. One of these is over three and another over two miles in length. Following up the main river, at about nine miles, in a straight line, southwest of Fleming's Lake, we enter Mountain Lake, which has the same general bearing, and is three and a-half miles in length. A rapid, about a mile above Mountain Lake, interrupts canoe-navigation for the first time in the thirty-one miles of this river and its chain of lakes which we examined; while below the point reached by us, opposite Wa-wong Lake, the Indians informed us that no portage occurred for a long distance. The whole country explored in connection with the Manitou-namaig and Ka-wa-kash-ka-ga-ma Rivers, is comparatively level. Here and there a gneissoid hill is seen rising one or two hundred feet above the general surface. The most remarkable is Granite Mountain, on the south side of Mountain Lake, which is composed of granite or massive gneiss, and has an elevation of about 200 feet over the lake. This region is overspread with a fine yellowish sand, beneath which a considerable thickness of gravel is found in some places, and underlying all, a light-colored clay is occasionally seen. The sand and gravel are largely developed around Wa-wong and Fleming's Lakes, whose banks are from fifty to 150 feet in height, the shores consisting of smooth curving sandy beaches. Back from these lakes, the surface of the country is rolling, and the soil generally of a light sandy and gravelly character. The wood consits of white birch, aspen, tamarack, spruce, balsam-fir, white-cedar and the Banksian pine or "cypress;" many of the trees being large enough to be of value for timber.

Level country.

A country similar to the one just described is reported to extend in the neighborhood of the height of land, westward to Lake Nipigon and eastward to New Brunswick House, on the Moose River. As illustrating the general level nature of a portion of this region, I may refer to the fact that we did not find it necessary to make a single portage in going all the way from the English River to Head Lake, except the short one already mentioned at the mouth of the Manitou-namai River; while the outline of the country on either side of this river and the lakes was usually low and level. As already stated, no portage occurs along the Ka-wa-kash-ka-ga-ma River in the part examined (about thirty-one miles), or for some distance further down.

The rocks met with in the country explored northwest of Long Lake House consist of Laurentian gneiss with some black mica-schists. It will be observed by the following list that the general strike is west-southwesterly, the same as throughout the extensive regions already referred to:—

Dip and Strike of Gneiss and Mica-Schist.

		Mag. Bearing.
1.	Manitou-namaig River, below the lake, Dip southward, < 70° ...	S. 60° W.
2.	Chute above Arm Lake, on the same river, Dip northward, < 70° ...	S. 75° W.
3.	Chute on Mink Brook. Vertical...	S. 80° W.
4.	North side of Head Lake; rock very massive, ...	W.
5.	On portage from the last to Fleming's Lake, ...	S. 80° W.
6.	N.E. extremity of Fleming's Lake, ...	W.
7.	On river between this and the next lake; black mica-schist. Dip northward, < 80° ...	S. 65° W.
8.	Islet near outlet of Ka-wa-kash-ka-ga-ma Lake, ...	S. 55° W.
9.	Island in N.E. part of do...	S. 50° W.
10.	Outlet of Island-camp Lake; contorted beds ...	S. 40° W.
11.	Camp Island, in the same lake. Dip southward, < 70° ...	S. 80° W.
12.	Outlet of Shallow Lake. Vertical ...	S. 65° W.
13.	North side of same lake; black mica-schist ...	S. 60° W.
14.	Granite Mountain on S.E. side of Mountain Lake,...	S. 60° W.

Black mica-schists.

The bedding of the black mica-schist, which occurs on the river between Fleming's and Ka-wa-kash-ka-ga-ma Lakes, and on the north side of Shallow Lake, is very even, close and regular. The rock is coarser and harder, as well as darker than the fine-grained green mica-schists of the Summit Portage, and Long Lake, and it holds quartz in the form of separate white grains. Many small veins and strings of white quartz run with the strike, and a few small short veins of the same mineral cut it transversely. The rock also holds strings and patches of epidote.

The granite at the outlet of Mountain Lake, and in the hill on the south-east side of it, is of a light reddish-grey color, rather fine-grained in texture, and composed of quartz, feldspar and mica.

White River.

White River.

The White River enters Lake Superior four miles south of the Pic. The distance from the mouth to the outlet of Natamasagami (or White Lake,) which lies upon this river, is twenty-eight miles, in a straight line bearing N. 75° E. In this distance, however, it makes a large angle to the south, in which it receives the Os-ka-boo-ku-ta River. Natamasagami Lake lies in a northerly direction, and is about eighteen miles in length. It averages less than forty chains in width in the lower half, but in the upper portion it expands to more than three miles. Over thirty islands occur in this lake. A large tributary, which forms part of a canoe-route across the height of land, enters from the northeastward, at four and a half miles from the outlet. The main river, which was not explored any further, enters the north-

east extremity of the lake. The Indians report the country to be comparatively level, along the courses of both these streams. An extensive view was obtained of the region to the north-east of the lake, and, as far as the eye could reach, it appeared low, level, and well-timbered. Around the rest of the lake, the country is also thickly wooded, but undulating and rocky; rising from forty to eighty feet above the water on the west side, and from thirty to one hundred on the east. Below the outlet, it becomes, in a general way, more mountainous towards Lake Superior; the hills varying from fifty to 150 feet above the river. The timber is burnt in some places, but over the greater part of the region it remains green. Good soil is occasionally met with near the river, but at a distance from it the surface is generally rocky. The Indians report a more level country along the Os-ka-boo-ku-ta River. Level wooded country.

The White River consists of a series of dead-water reaches between the falls and rapids which give rise to the eighteen portages below the Natamasagami Lake. Except at these interruptions, the river measures from 200 to 400 feet in width. It is generally pretty deep in the middle, the shallowest sounding having been thirteen feet; while in many places the depth was found to be from thirty to forty feet. From the mouth to the sixteenth portage, which is two and a half miles below the outlet of Natamasagami Lake, the river runs entirely upon greyish and reddish gneiss, mostly of a massive granitic character, striking W.S.W., and dipping northward at angles varying from 30° to 80°. It is occasionally interstratified with bands of dark hornblendic schist and very light grey gneiss. Fine-grained dark green hornblendic schists, having the same strike, occur between the sixteenth portage and the outlet. Around the lake the strike was found to have changed to N.N.W., which is at right angles to its previous course, and the prevailing dip is westward, at angles varying from 30° to 50°. Gneiss, mostly of a granitic character, occurs all around the lake and on the islands, with the exception of the central part, where both shores are occupied by hornblendic, silicious and chloritic schists, with occasionally a thin interstratified layer of gneiss. Similar schists, with bands of gneiss, appear to rest comformably upon the massive gneisses at a short distance north of the river, all the way from Natamasagami Lake to the mouth. Massive gneisses. Huronian schists.

As is shewn in the following table, eighteen portages are met with on White River, in going to Natamasagami Lake. It is worthy of note that the same number of portages occurs on the Pic River route from Lake Superior to Long Lake; and also on the Kenogami River in going from Long Lake to the Albany River, or to the sea-level.

Portages on White River, counting from Lake Superior.

Portages.

No. of Portage.	Distance in a straight line from mouth, in miles.	Side of River.	Length in chains.	Rise, in feet.	Remarks.
I.	1⅔	S.	27	49	Chi-ga-mi-win-i-gum Falls.
II.	1¾	S.	6	27	
III.	2	N.	5	15	
IV.	4	N.	12	27	
V.	4¼	N.	12	25	
VI.	5¾	N.	1	2	
VII.	6	N.	40	98	Umbabata Falls. One perpendicular leap of 57 feet.
VIII.	6½	S.	18	38	
IX.	16½	N.	16	21	
X.	18½	N.	1	4	
XI.	19	S.	30	10	Herrick's line Portage.
XII.	20	N.	34	39	Chicagonse Portage.
XIII.	22½	S.	1	3	Ma-shi-ba-shi Portage.
XIV.	24¼	S.	2	4	
XV.	25¼	N.	20	15	
XVI.	25½	N.	15	4	
XVII.	26	S.	35	22	
XVIII.	27	S.	8	2	

Black River.

Black River.

The Black River enters the Pic on the east side, about two miles from Lake Superior. From this point to Herrick's line the distance is seventeen miles in a straight course, bearing N. 60° E. The river runs near the centre of a trough of Huronian rocks, which have a breadth, in this distance, of about twenty miles. The country occupied by these strata has a more diversified character than the Laurentian regions. It consists of plateaus and wide valleys, with rounded hills more or less completely separated from one another. Below Herrick's line, the land on either side of the river is of the same character as in the lower part of the valley of the Pic. Terraces of stratified bluish-drab clay and fine yellow sand rise to heights varying from forty to one hundred feet above the river. These deposits sometimes extend to a distance of several miles from the river, forming apparently a good soil. In the more level tracts, the surface is swampy in places, but in such localities the land could be easily drained.

Huronian schists.

The rocks examined on either side of the river consist of dark greyish-green and reddish diorites and dioritic schists, (some of them porphyritic), red and grey granites, fine grained mica-schist, conglomerates, silicious, argillaceous, hornblendic, chloritic, feldspathic and epidotic schists; and the same imperfect grey gneisses which have been described as occurring on the Pic River. The general strike is west-southwesterly, although many local exceptions occur, and the prevailing dip is northward at high angles.

Portages on Black River.

No. of Portage.	Miles from mouth in a straight line.	Side of River.	Length in chains.	Rise, in feet.	Remarks.
I.	3	N.	18	140	
II.	$6\frac{1}{4}$	N.	11	6	
III.	$17\frac{1}{4}$	S.	59	76	Herrick's line Portage.
IV.	$19\frac{1}{2}$	S.	30	20	

The river was explored for about five miles above the fourth portage, and found to be uninterrupted, for that distance, at least.

Little Pic River.

This stream enters Lake Superior in the bottom of a bay lying north of Pic Island, about twenty miles north-west of the mouth of the (Great) Pic River. The general course of the river is very straight from the mouth up to Herrick's line, which it intersects at a distance of twenty-two miles, in a straight course bearing N. 26° E. (mag.) In this distance the valley of the river, which will average about a mile in width, is covered in most parts with a light yellowish loamy soil. Little Pic river.

The rock at the mouth of the river, on the west side, consists of a massive crystalline granitoid rock, composed chiefly of red orthoclase with a little black hornblende, holding thick beds or veins of magnetic iron ore. In one place on the river, a mass was observed enclosing fragments of greenish diorite and dioritic schists of all sizes. Steep and almost naked hills, apparently all of the same granitoid rock, from 250 to 600 feet high, run close to the west side of the river, for about eight miles from the mouth. At this distance, a rusty-weathering mica-schist occurs, and immediately north of it, coarse grey gneiss, running nearly west. Gneiss, associated in places with hornblendic and micaceous schists, continues all the way up to the intersection of the river with Herrick's line, and westward from this point to Whitefish Lake. Hills, apparently of the same kind of rock, occur also on the east side of the river, near the mouth, but at a greater distance back, and with a less elevation. Greyish and greenish dioritic-schists were met with on the west side of the reddish granitoid rock with iron ore, beginning at about a mile and a quarter from the mouth of the river. The Little Pic River is about one chain wide in the part surveyed, shallow, and rather rapid. Huronian schists.

Portages on the Little Pic River.

No. of Portage.	Distance in a straight line from mouth, in miles.	Side of River.	Length in chains.	Rise in feet.	Remarks.
I.	4	W.	8	18	
II.	4	W.	12	27	
III.	15¼	E.	9	29	Lake Falls.
IV.	18½	W.	13	14	
V.	22	W.	6	6	

Economic Minerals.

Iron ore.

The principal deposit of iron met with in the region explored is on the west side of the mouth of the Little Pic River, where as already mentioned, thick beds or veins of iron ore are associated with a reddish granitoid rock. The united thickness of three of these, which occupy a horizontal position in a cliff, appears to be about ninety feet. A sample of this ore, assayed by Dr. Hayes, of Boston, yielded thirty-six per cent of metallic iron, and another assayed by Dr. Girdwood of Montreal, from a different spot at this locality, contained forty-six per cent of metal. Dr. Hunt finds a specimen which we brought to contain 36·85 per cent of iron, chiefly as a silicate.

A band of impure slaty hematite ore was found by Mr. McKellar on the west point of the largest of the Slate Islands, and Mr. Beatty shewed me a specimen of a fine grained silicious slaty magnetic ore, which he took from a band two feet thick on the portage at the west end of Little Long Lake.

Copper.

Copper-ore was found in small veins cutting the Huronian schists in a number of places in the valley of the Black River, but no important deposit of this metal came under our observation during the season.

Gold.

It is worth remarking that gold may yet be found in the quartz veins (such as those of the Summit Portage) in the fine grained mica-schists; as Professor Chapman informs me that he has already found it in similar veins in micaceous rocks in the country on the northwest side of Lake Superior; and it is not improbable that tin-ore may be discovered in the granite veins of the tender grey mica-schists of the same region. These, according to Dr. Hunt, resemble closely the mica-schists of the White Mountain series, which have afforded tin-ore both in Maine and New Hampshire (see page 312.)

Tin.

The probable future value of the limestone fragments of the drift for burning into lime, may also be mentioned.

SURFACE-GEOLOGY, SOIL, TIMBER AND CLIMATE.

In the region around Long Lake the direction of the glacial striæ varies from S. to S. 25° W. The grooving is as well marked on the rounded tops of the highest hills as in the valleys. Along the Pic River the average direction is from S. 20° W. to S. 30° W.; while on the English River it was found to vary from S. to S. 60° W., although the prevailing direction was from S. 30° to 50° W. In the country north-west of Long Lake House, the average direction was between S. 30° and 40° W. Boulders occur principally in ridges by themselves, or scattered upon the surface of the bare rocks, very few having been observed mixed with the finer materials of the surface-deposits. Transported boulders, generally well rounded, and often large, were found perched on the sides and tops of the hills. The moraines or ridges of boulders, mostly small and rounded, are very conspicuous along both sides of Long Lake, for the last four miles towards the southern extremity, and down the valley of Black River, as far at least as Herrick's line. These ridges occur at all heights up to about 200 feet over Long Lake. Similar moraines run down the sides of a valley leading S. S. W., from Jack-fish Pond, between the 4th and 5th portages on the Pic. Beatty's line crosses this valley about three miles west of its intersection with the Pic. The smaller rapids in the Pic and other rivers, on both sides of the watershed, are generally caused by low ridges of small rounded boulders crossing the bed of the stream. Fleming's Lake is raised to its present level by such a ridge, about twelve feet high, running N. 35° W., in a very straight course across the outlet.

Ice-grooves.

Boulders.

The drift, having come from the north-eastward, is rich in pebbles and boulders of the paleozoic limestones, which occur, *in situ*, in that direction. These are washed out and exposed in the banks of lakes, and along rivers and brooks, especially at rapids, and may, some day, prove valuable for burning into lime. The fossils, which they contain, are mostly silicified, and indicate the Niagara formation. In a gravelly bank on the west side of Natamasagami Lake, Mr. McKellar collected specimens of the following genera, as determined by Mr. Billings: *Stromatopora*, *Favosites*, *Zaphrentis*, *Cystiphyllum*, *Halysites*, *Strophomena* and *Spirifera*; specimens of some of these genera were found in the limestone fragments in many other localities.

Limestone drift.

The thick deposits of clay and sand, occurring along the Black River, and the Pic as far up as the Fourth or Dying Portage, as already stated are rich in carbonate of lime, and may afford a considerable extent of good soil. Above the fourth portage, the bottom of the valley, except where occupied by rocks *in situ*, is covered with sandy loam, and, towards the outlet of McKay's Lake, with a light yellowish sand. Sand also prevails in the valley which extends from the north-east extremity of this lake to Pow-gutch-a-wan Lake. But little soil was observed elsewhere among the hills around either of these lakes.

Soil.

Sands. The shores of Long Lake are mostly rocky, but banks of light colored fine clayey sand are met with in some parts, and are conspicuous at the narrow place, which takes its name Ka-wa-ba-tongwa, or the White Sand Banks, from this circumstance. Here, on the east side, this sand rises to a height of upwards of 100 feet over the lake.

North-west of Long Lake House, the country is overspread with a sandy and gravelly deposit, which appears to be too light to form a good soil, except in some places. Owing to its level character, much of the surface is swampy; but as nearly as can be judged by our explorations, only a comparatively small portion of the whole area is rocky. These sandy deposits, as already mentioned, are underlaid by a light-colored clay, which occasionally comes to the surface, and in cross sections, shews lines of stratification. The Hudson Bay Company's farm at Long Lake House, is situated on this clay formation, and a specimen taken here at a depth of about two feet, was found by Dr. Hunt to contain over twenty per cent. of carbonate of lime; while one from another part of the deposit, in the valley of the Making-ground River at the Summit Portage, proves to contain little or no lime. Mr. Walter Beatty, P.L.S., informed me that the surface is of a similar character all along his line from Humboldt's Bay on Lake Nipigon, to Long Lake, and also along the canoe-route from Poplar Lodge to Long Lake House.

Clays.

Soil. It has been already mentioned that a brownish gravelly loam is exposed in the banks of the English River, and that at a distance back from the stream, much of the surface is swampy, especially in the lower portions explored.

In a general way, it may be said that the whole country examined, north of the hilly region around Lake Superior and east of Lake Nipigon, is comparatively level, with a sandy soil, generally dry, but in places interrupted by shallow swamps and low rocky ridges. The soil appears to be for the most part naturally poor, and, over a considerable proportion of this area, it has been rendered worse by the burning-out of the vegetable mould by repeated fires.

The old timber consists in order of abundance, of spruce, balsam-fir, tamarack, white birch, aspen, white cedar, Banksian pine or "cypress," and balsam-poplar; but after the fires the new growth consists principally of white birch and aspen. The tamarack, Banksian pine, and white cedar will prove of value for sleepers and ties, culverts, telegraph-poles, &c., in the construction of the proposed Canadian Pacific Railway; while the country along any route through this region will always afford abundance of wood for fuel.

The climate appears to be no worse than that of parts of the Province of Quebec, which are already inhabited. In going from Lake Superior to the valley of the Albany, no difference was observed in the character of the vegetation; which may be accounted for by the greater elevation of the southern part, together with the cooling influence which Lake Superior

exerts upon it. Oats and barley have been successfully cultivated at Long Lake House, while hay, potatoes, and all the ordinary vegetables thrive remarkably well. Last year the potatoe-tops had not been touched by frost up to the time of harvesting, which was during the first week in October.

I have the honor to be, Sir,

Your most obedient servant,

ROBERT BELL.